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STUDIES IN THE NATURAL HISTORY OF THE SACRAMENTO SALMON.

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THE following notes are derived mainly from a series of investigations carried on under the direction of the U. S. Commissioner of Fish and Fisheries, by whose permission they are here used.

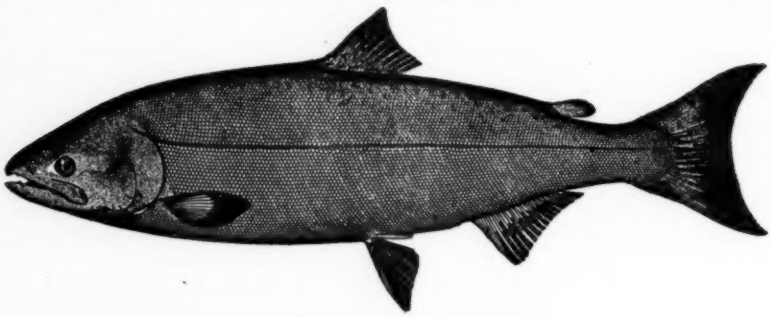
The Pacific salmons, the genus *Oncorhynchus,* of which there are five species, are very distinct from the Atlantic salmon of the genus *Salmo.* In fact, they have no more right to the name salmon than wolves have to the name fox. Anatomically the two genera do not differ greatly—*Oncorhynchus* having 14 or more rays in the anal fin, and *Salmo* 10 to 12—but physiologically and in life-history they differ in a marked degree.

The most important difference lies in the fact that the Pacific salmon, of whatever species, dies immediately after spawning once. This is true of both males and females, and is a very remarkable characteristic. It is often denied upon *a priori* reasoning, the common argument being that, if they all died on the spawning beds the rivers would be full of dead salmon floating down stream. But the common idea that dead fishes float is erroneous. Those that die a natural death do not float, and the salmon is not an exception.

Natural Propagation.

Under natural conditions, the female salmon extrudes the ova, a few at a time, in a swift current near the bottom of the stream. Many are carried several feet, or even yards, down stream by the current, and are nearly always devoured by other fishes, such as the trout, sculpin,

Sacramento pike and split-tail. Some of them, at least, are caught in the eddies formed among the cobble stones, and are held near the 'nest,' or hillock of gravel thrown up by the spawning fishes. These



SACRAMENTO SALMON.

are covered by the sand and protected, though many are covered too deeply and are killed.

Salmon ova are about .25 inch in diameter. The 'shell' is membranous and finely porous, with a minute aperture, somewhat larger than the pores, known as the micropyle. When first extruded the ova

MCCLOUD RIVER, NEAR BAIRD, A TYPICAL SPAWNING STREAM.

are soft and compressible, and it is while in this condition that they must be fertilized. Within two or three minutes after being deposited in the water they become turgid, and are then incapable of fertilization.

Immediately after the extrusion of a few ova, the female moves away from the 'nest,' and the male takes her exact position, or sometimes a little down stream from it, and extrudes a small quantity of milt. The milt is a milky white fluid as full of spermatozoa as blood is of corpuscles. It rapidly disseminates through the water, and is carried away by the current just as the ova were. Doubtless many hundred spermatozoa come in contact with each ovum, though probably only one finds its way through the micropyle, which causes fertilization. The salmon egg is too large to permit a microscopic examination of the process of fertilization, though without doubt it is the same as in other fishes.

Artificial Propagation.

Fertilization is secured at fish culture stations by expressing the ova and milt simultaneously into a pan and thoroughly mixing them by stirring with a feather or the fingers. Two methods of procedure are in vogue among salmon culturists. The one, known as the 'dry' method, consists in expressing the ova and milt into a pan that has been merely rinsed with water; in the other, known locally as the 'wet' method, about a pint of water is placed in the pan before the spawning. A careful comparison of the results has failed to show any difference. The 'wet' method requires a less quantity of milt, which is sometimes a desideratum.

Numerous experiments were performed testing the vitality of ova and milt under various conditions, of which I note the following:

A quantity of the ordinary creek water, such as was used in artificial propagation, was spermatized, and a portion of it used for fertilizing ova at various periods after the spermatization, in order to test the vitality of spermatozoa in water. The following results were obtained from one experiment, which may be considered typical:

Time milt had been in water. Minutes.	Percentage of fertilization.	Time milt had been in water. Minutes.	Percentage of fertilization.
¼	98	4	0
½	88	5	0
1	38	6	0
1½	4	7	2
2	8	8	0
3	8		

Similar experiments were performed with the ova, to determine their susceptibility to fertilization after being immersed in water for various periods. The following results were obtained from one series, which are typical of the others:

Time ova had been in water. Minutes.	Percentage of fertilization.	Time ova had been in water. Minutes.	Percentage of fertilization.
¼	98	4	4
½	96	5	4
1	95	6	0
1½	68	7	1
2	57	More than 7	0
3	17		

The average salmon produces about 6,000 ova. In artificial propagation from 5 to 20 per cent. cannot be spawned. These can be removed only by slitting the fish open, in which case a considerable quantity of blood is mixed with them. If the blood is not washed off, the fertilization cannot be made complete, as many of the ova become surrounded with clotted blood. But, if the blood is washed off with water, the ova immediately become turgid and not susceptible of fertilization. The difficulty was overcome as follows:

Among the many experiments testing the vitality of the ova and their susceptibility to fertilization under various conditions, one determined their reaction to normal salt solution. By normal salt solution, is meant water of the same degree of saltness as the body fluids, which in the case of the salmon we assumed to be .75 of 1 per cent., no chemical determinations having been made. Ova were spawned into a pan containing normal salt solution, and after various periods of time a few were removed and spermatized in the ordinary manner, with the following results:

Time ova had been in salt solution. Minutes.	Percentage of fertilization.	Time ova had been in salt solution. Minutes.	Percentage of fertilization.
2	99	8	99
4	100	15	97
6	100	25	86

Compare this table with the one showing the effect of pure water on the ova. Acting upon the information gained in this experiment, we removed the unspawned ova from the fishes, washed off the blood with normal salt solution, and fertilized them just as we did other ova, thus saving a large percentage that had previously been lost.

Habits of the Young.

Before this series of investigations was begun, fish culturists were able to hatch artificially from 80 to 90 per cent. of the eggs taken, and it did not seem that much improvement in that line was probable. But there was considerable question as to the best methods of planting the young. We were entirely ignorant concerning the life of the young in the streams, knew nothing of their food, nor of their enemies, and knew only in a general way that they migrate to salt water. Our most important study, therefore, was that of the natural history of the young, and later of the adult also. The following are some of the results of our investigations:

AN ALEVIN.

A FRY, AT THE BEGINNING OF THE MIGRATION.

The time required for salmon eggs to hatch is about 50 days, though it varies from one to six months, according to the temperature of the water. When the young first leaves the shell, it is attached to a large mass of yolk, and is known as an *alevin*. It is a very helpless creature, cannot swim and fortunately does not need to eat, the yolk supplying the needs of growth.

For three or four weeks the alevin lies quietly at the bottom of the stream in the crevices of the stones. By that time the quantity of the yolk becomes so small that there is a desire for more food, and the alevin occasionally leaves the bottom to snap at some floating particle. It is at this time, while the movements are slow on account of the unabsorbed yolk, that the young under natural conditions are in the greatest danger from other fishes. In artificial propagation they are protected during this period, and it is only after the complete absorption of the yolk that they are liberated in the streams. At this age they are known as *fry*.

The fry are practically without enemies. The stomachs of more than a thousand trout taken in streams inhabited by young salmon have been examined, but in no instance has a fry salmon been found, though alevins were common enough. Many Sacramento pike and striped bass have also been examined with a like result. There can be

little doubt that the salmon fry in fresh water is able to take care of itself.

Our most extended observations were made on the migratory habits of the fry, and I give a somewhat detailed account of them. In May and June, 1898, we visited all parts of the Sacramento River, from its source to Suisun and San Pablo bays, and even traveled 250 miles down the river in a rowboat. We were equipped with fine-meshed seines which we used wherever it seemed practicable or desirable to gain information concerning the young salmon. We found them abundant everywhere above the middle portion of the river, and in a decreasing number all the way down to the mouth, and along the shores of the bays. We considered them abundant when we caught anywhere from 25 to 400 at a single haul of a 50-foot seine. They were about two inches long wherever taken. The same observations were made again in July. In the headwaters, at the Sims, the fry were as abundant as at the previous examination. There were fewer at Redding, very few at the mouth of Battle Creek, and none at all below the latter point. All that we had found on the previous examination had gone down stream and had passed into salt water. As we afterward learned, the salmon fry observed during this first examination were merely the last of the season's migration, and not all of it, as we first supposed.

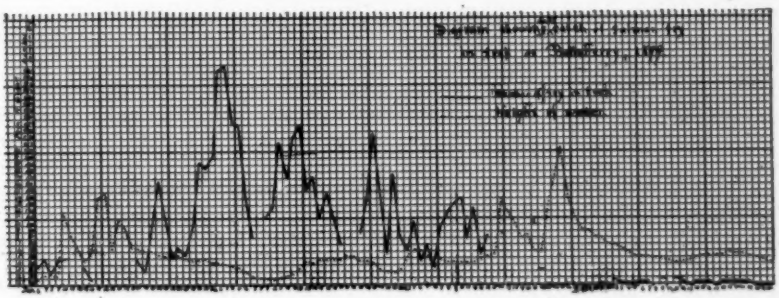
While at Battle Creek Hatchery during October and November, 1898, we continued the observations by setting a trap in Battle Creek, and so arranging it that it caught only such fishes as were going down stream. By this means we soon learned that the fry begin their migration much earlier and younger than our previous summer's work had led us to suppose. The following is a record of the daily catch of the trap:

Date.	Time.	No.	Date.	Time.	No.
Oct. 7	Day	0	Nov. 12	Night	6
" 8	Night	5	" 13	Day	0
" 9	Night	1		Night	26
" 11	Night	3	" 14	Night	27
" 12	Night	17	" 17	8-9 P. M.	17
" 13	Day	0	" 21	3-4 A. M.	83
	Night	7	" 22	4-5 A. M.	6
" 14	Day	0	" 24	12-1 A. M.	1
	Night	10	" 25	1-2 A. M.	5
" 16	Day	0	" 26	1-2 A. M.	15
	Night	8	" 27	2-3 A. M.	0
" 17	Day	0	" 28	2-3 P. M.	0
	Night	6	" 30	1-2 A. M.	49
" 21	Night	11		8-9 A. M.	24
" 24	Day	0			
	Night	2			
" 25	5-9 P. M.	4			
	Night	6			

Of the 339 young salmon taken in the trap, 322 were under 2 inches long, and 17 over 4 inches. 178 of the smaller specimens were measured accurately with the following results:

Size, inches,	1.4	1.5	1.6	1.7	1.8
Number,	23	100	53	1	1

The smallest had just absorbed the yolk-sac, and in many there was yet a small quantity of yolk remaining. Those 1.6 inches long had not been feeding over three weeks, as other observations show that they grow at the rate of .3 inch a month. That we found young salmon that had barely absorbed the yolk-sac indicates that they begin their migration as soon as they are able to swim. That they remained of the same size from October 8 to November 30 indicates that practically all start down stream at the same age. If any of the same age as those taken October 8 had been taken during the last days of observation, the fact would have been indicated by their increased size. In 53 days they would have grown over half an inch, and would have been at least two inches long. There were no intermediate sizes

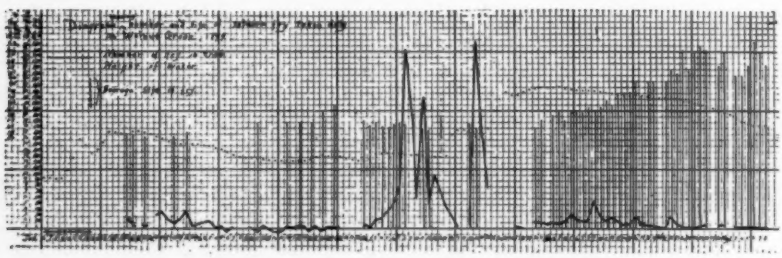


between 1.8 inches and 4.0 inches. The larger individuals had remained over from the previous year. The trap was so set that they could not have avoided it during the day. The fact that none was taken during the day indicates that they travel more or altogether at night. The last record shows that 24 were taken from 8 to 9 A.M., which is the only day record. This is accounted for by high and muddy water, caused by a heavy rain during the previous night. This and other observations indicate that high and muddy water, especially the latter, is an incentive to day travel.

The two months' observations with the trap at Battle Creek were deemed of such importance that two observation stations were established on the river the first of January, 1899, and equipped with similar traps. The upper station was established at Balls Ferry, some three miles above the mouth of Battle Creek; the other at Walnut Grove on the lower river. The diagrams indicate the number of salmon fry taken in the traps at the two stations:

The diagrams indicate the passage of the fry from the fall run of adults; those from the summer run passed the upper station earlier, some of them being noted at Battle Creek during October and November. Observations in 1900 show that they may begin migrating in September.

The work at Balls Ferry indicates that the greater part of the young salmon passed that portion of the river between the middle of January and the middle of March. Practically all had passed by March 20. Numerous measurements made at frequent intervals show that the daily average size varied but one tenth of an inch during the three and a half months. The average of all measurements is 1.53 inches. This confirms the inference from the Battle Creek work that practically all the fry begin their migration as soon as they are able to swim, otherwise the later ones would have been larger.



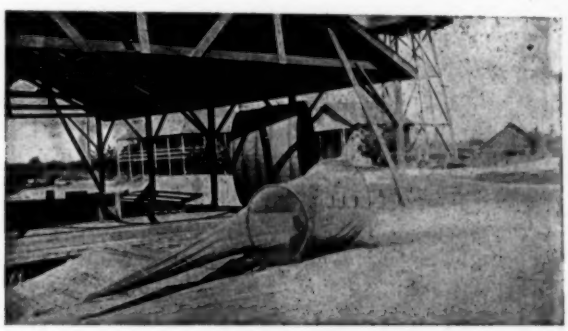
Both diagrams show that a big run of fry is not necessarily coincident with a rise in the river. From the Walnut Grove diagrams we note. From the middle of January to the middle of May there were salmon fry in various numbers passing Walnut Grove. The height of the migration was from March 4 to about the 24th, lasting about 20 days. Practically all had passed by April 22. The size of those taken during January was 1.6 inches, during February 1.8 inches, during March 1.7 inches. From March 30 to May 7 they increased from 1.7 inches to 3.0 inches. The field notes show that as many fry were taken during the day as at night. The water of this portion of the river is muddy.

Comparing the two diagrams we note that a large run of fry passed Balls Ferry February 2, and that 34 days later, March 8, there was a large run of fry passing Walnut Grove. Again, a large run passed Balls Ferry February 14, and 34 days later, March 20, there was a large run passing Walnut Grove. The later Balls Ferry runs were caught by the high water the last of March, and their passage was not noticed at Walnut Grove. The high water probably carried them down faster, and they may have passed while the trap was out of the water, March 23 to 26.

The average size of the fry passing Balls Ferry January 30 was 1.51 inches, and of those passing Walnut Grove 34 days later 1.79 inches, an increase of .28 of an inch. Those passing Balls Ferry February 18 were 1.48 inches long, and 34 days later at Walnut Grove 1.77 inches, an increase of .29 inch. We have learned from other sources that the fry increase in length about .30 inch a month, and .28 and .29 inch in 34 days is not far from that rate.

It seems, therefore, both from the size and number taken at the two stations, that fry are about 34 days in passing from the upper to the lower station. The distance between the two stations is about 350 miles, as the river winds, and their average daily progress is therefore about 10 miles a day.

An object floating with the current would make the distance between the stations in less than 10 days, and if fry traveled only at night and merely kept with the current, they would be only 18 or 20 days on the way. It is probable that fry in migrating drift down stream tail first, keeping the head up stream for ease in breathing, as well as for con-



WALNUT GROVE TRAP.

venience in catching food. In this way they would drift more slowly than the current. I have seen fry at Battle Creek fishery traveling with the current, and always with the head up stream, unless frightened. The later and larger specimens found at Walnut Grove had simply been longer on the road. The larger they became the more slowly they drifted. Without doubt there are a few passing down the river all summer, though we have been unable to find any after June.

Much seining was done along the shores of Suisun, San Pablo and San Francisco bays, and in Tomales Bay, to determine something of the fry in brackish and salt water. Very few specimens were taken, probably not over 50. The smallest specimens taken in San Pablo Bay were 2.4 inches long, which indicates an age of about 4½ months, and a period of three months for the migration.

A net stretched across the mouth of Olema Creek, emptying into

Tomales Bay, caught salmon fry coming back into the stream at flood tide. This indicates that they regularly travel back and forth with the tides. We should expect this, as it is hardly probable that they know any directions, except with or against the current.

Many experiments were performed at the Hopkins Seaside Laboratory for the purpose of determining the effect of sea-water upon young salmon of various ages. 25,000 salmon were hatched in the laboratory, and at various ages a few were placed in separate tanks and subjected to various mixtures of fresh sea-water. Without going into details of the experiments, the following are the results obtained:

The young of any age can bear with impunity a density of 25 per cent. sea-water; that is, 1 part sea-water to 3 parts fresh water. Not until forty days old, at the time of the complete absorption of the yolk-sac, could they withstand a density of 50 per cent. sea-water. At the age of 50 days 75 per cent. sea-water could be endured. Pure sea-water could be endured at the age of 60 days, though there was a slight loss. It is doubtful whether they can enter salt water with complete impunity until 3 or 4 months old. The loss was much less when the density alternated from low to high and back again, simulating the change of density in the estuaries with the change of tides. In all cases the young salmon died when changed directly from fresh to salt water, or when the density was rapidly increased until that of sea-water was reached.

To summarize the notes on migration: The fry begin their down stream migration as soon as they are able to swim. In clear water they travel more at night; in muddy water, as much or more during the day. Much of the time they float down stream tail first. In the larger streams they travel more or less in schools. Their regular migration is not dependent upon the height of the water, but upon age. Their rate of progress is about 10 miles a day, and they are about six weeks in reaching brackish water. They are probably four or five months old when they reach the ocean.

A PARR, SIZE UPON ENTERING THE OCEAN.

Summer Residents.

In the upper portion of Sacramento River and its tributaries there remains after the winter and spring migration a large number of young

salmon. In the vicinity of Sims in 1898 we found 700 to 1,000 in the various pools. They were common in McCloud River in September, and in Fall River in August.

These summer residents, as they may be called, are confined to the headwaters, the clear streams with rocky bottoms. They do not stay much of the time in the swift current or riffles, but remain in the more quiet pools, where they feed on insects and take the angler's fly the same as trout. Considerable effort was made to learn as much as possible concerning them, and Sacramento River near Sims and its tributary, Hazel Creek, were visited each month from May to December with that end in view.

During July and August, all specimens taken were marked by cutting off the adipose fin, by which means we were able to make estimates of the number in the pools, their rate of migration, and their rate of growth. The number estimates were made thus: After having marked a few and released them in the pool, the following proportion was formed with the data from each seine-haul: the number of marked fry taken is to the number of marked fry in the pool, as the total number taken is to *the total number in the pool.* In August, when we could distinguish those just marked from those marked in July, we were able to make estimates of the number of July-marked fry in a pool and, knowing the number released there in July, to compute the rate of migration for the month.

The following table gives the result of the work in one pool, and illustrates the data used in making the number estimates:

Date.	No. caught.	No. previously marked.	No. marked fry caught.	Estimated No. in pool.
Aug. 16 P. M.	66	1	1	
"	148	66	13	751
"	146	197	30	992
Aug. 17 A. M.	83	312	38	682
"	47	357	19	883
"	19	385	4	1804
"	64	400	25	1024
"	149	439	62	1055
"	71	525	40	932
"	35	556	15	1297
Aug. 17 P. M.	19	576	9	1216
"	3	586	3	586
Total different individuals, 24 hrs., 586			Average of estimates,	1022

The average estimates for two other smaller pools are 685 and 861. From these estimates it seems probable that there were about 10,000 young salmon to the mile in the upper Sacramento during the summer of 1898, or less than a million in all the headwaters, which is a very

small percentage of the year's product for the river. At Battle Creek Hatchery alone that year, 1897–8, there were nearly 50,000,000 eggs taken. There is little migration of the young salmon during the summer months. In August we could account for 94 per cent. of the fry we had marked in one of the pools in July; 76 per cent. in the pool in which they were released, and 18 per cent. in the pool below.

The growth of the larger fry in fresh water is slow. The average size of the marked fishes in August was 3.91 inches, in September 3.86 inches, in October 4.20 inches, in November 4.20 inches, being a total gain of but .29 inch in three months. The earlier rate was .3 inch per month. Another effect of this summer residence in fresh water is the maturing of the male genital organs. A large proportion of the males that remain in fresh water until they reach a length of four inches becomes sexually mature. Its significance is not understood, and its effect upon the future growth of the fish is not known. The number of parasites found in the stomachs of young salmon living in fresh water increases with their size and with the time of year, there being more in the fall than earlier. Their food in fresh water at all ages, seasons, and places is insects, about two thirds being aquatic larvæ, and the other third adult insects.

The Adult.

As stated above, young salmon reach the ocean when four or five months old. Concerning their habits from that time until they return to fresh water at maturity, we know very little. They are occasionally taken in the ocean near San Francisco, but so rarely as to indicate very little concerning their habits. They are abundant in Monterey Bay during the spring and early summer, but their appearance there is only the first step in their migration up the rivers to spawn.

The length of their stay in the ocean has been determined with considerable certainty by a series of observations carried on recently with the Columbia River salmon, which is the same species as the Sacramento salmon. In May, 1896, 5,000 young salmon 2.5 inches long were marked by cutting off the adipose fin, and were released in the Clackamas River, a tributary of the Columbia. The eggs from which they were hatched were spawned in September, 1895. During the summer of 1898, a little over two years after the marking, and a little less than three years after the spawning of the eggs, 375 of the marked salmon were taken in the Columbia, and five were taken in the Sacramento River in California. A few more were taken both in the Columbia and in the Sacramento in 1899, and again in 1900. The size of those taken in 1898 varied from 10 pounds to 57 pounds.

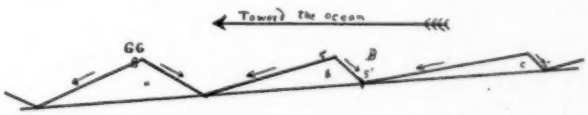
Besides indicating the age of the spawning salmon, this experiment shows that most salmon return to the river through which they reached the ocean. They do not do this because it is the stream in which

the parent fishes spawned—the 5,000 mentioned in the experiment were from eggs taken in California—but because their ocean feeding grounds are not far off-shore, and in their two years' residence in the ocean they have not wandered far from the point at which they entered it. When it comes time to return to fresh water, their native stream is the first to attract attention.

Adult salmon may be found in the Sacramento River at any time of year. There are, however, two distinct runs, the earlier of which passes up the river during April, May and June, and the later during August and September. The former is known as the spring run and the latter as the fall run. The salmon of the spring run ascend the river to the headwaters, such as the upper Sacramento, McCloud River and Hat Creek, and some of the earlier ones even pass Pit River Falls and enter Fall River. The salmon of this run spawn mainly in August. The fall salmon do not ascend the river so far as those of the spring run, but turn aside into the lower tributaries, or spawn in the main river. They reach their spawning grounds during the latter half of October, November, and the first half of December. The main river is very low at this time of year and only a small portion enter the tributaries.

Details of Migration.

When the salmon enter the bay from the ocean, they come in against the ebb-tide. They stem the current till the tide changes, and then run out against the flood-tide, losing much of the distance gained during the ebb. That they do not lose altogether as much as they gain may be understood from the following explanation:



The tide runs up the bay and river as a broad low wave, on the upper side of which is flood-tide, and on the lower side ebb-tide. This wave is about three hours going from San Francisco to Benicia; it reaches Collinsville in about four hours, and Rio Vista in four and a half hours. When the crest of a wave is at Isleton, its trough is about at the Golden Gate. The farther the tide extends up stream, the smaller the wave, the shorter the flood, and (as the flood and ebb must together equal twelve hours) the longer the ebb. The following diagram will illustrate the movements of a salmon in passing through the bays: *a, b* and *c* represent the tide-wave at successive points as it passes up the bay. ←≡ indicates ebb-tide, and ≡→ flood-tide. Suppose that a salmon enters the Golden Gate, *G G*, at the beginning of ebb-tide,

which would be the most favorable time. His position on the wave will be at *S*. If he is able to travel up the bay as fast as the wave he will keep his position near the crest, that is at *S*. But he can hardly do that, especially as the current would be very slight, and in the broad bay hardly strong enough for his guidance. Let us suppose that by the time he reaches Benicia, *B*, he has fallen behind the wave until he has the position at *S'*. It is then slack low water, and he can make no headway. Soon the next wave reaches him and he is in flood-tide. He will therefore swim back against the current. As the wave is going up the bay and he is going down, he soon gets past the crest and finds himself in the ebb-tide at *S''*. He then turns and stems the ebb-tide, and as the wave is going in the same direction he is, he goes much beyond Benicia, *B*, before he again falls back to slack low water at *S'''*, and gets into the flood of the next tide-wave.

MAP OF SACRAMENTO RIVER AND OUTLET, SHOWING STATIONS, BY NAMES OR NUMBERS, WHERE SALMON INQUIRIES HAVE BEEN MADE.

By taking the statistics of the daily catch of salmon at various points, we have been able to trace the progress of a school up stream, and find that it requires four days to pass from Vallejo to Sacramento. We have been unable to determine the length of time required to reach Vallejo after leaving the ocean.

The spring run passes up the river quite rapidly, reaching their spawning grounds in the McCloud River in about six weeks after entering the river at Collinsville. The fall run moves more slowly. The flood and ebb tides are more nearly equal, owing to the small amount of water coming from the rivers, which makes a longer passage through

the bay. After reaching the shoals in the middle portion of the river they move slowly, having already found pretty good spawning grounds. They are about two months reaching their spawning grounds (between stations 17 and 8 of the accompanying map), which are but little more than half as far up stream as those of the spring run.

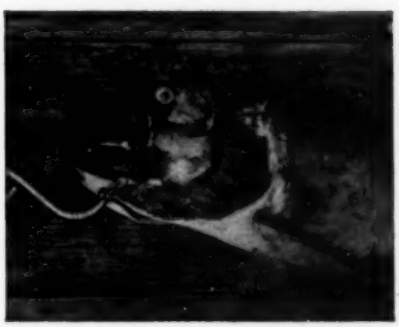
In September, 1901, over a hundred salmon were weighed and branded with serial numbers and released in the river at Rio Vista. Three of these were taken later upon their arrival at the spawning grounds. The following is a tabular statement of the data concerning them, the loss in weight being due to migration alone. No. 34 was 8 days in spawning, extruded all but 20 ova, and lost thereby 21 per cent. more of the Rio Vista weight.

No.	Sex.	Distance traveled, miles.	Time, days.	Loss in weight, percentage.
8	female	300	65	28
34	female	300	61	20
43	male	350	65	26

The salmon of the spring run reach their spawning grounds from two to six weeks, or even longer, before spawning, which time they spend lying quietly in the pools. The fall salmon are more nearly ripe when they arrive at the spawning grounds, many of them ceasing to ascend only when ready to spawn.

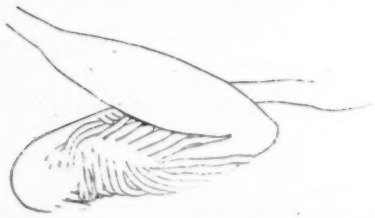
Spawning and Death.

Salmon are in fairly good condition when they begin spawning, notwithstanding the fact that they have been without food for several weeks or even months, and have traveled several hundred miles in the meantime. The male has changed his appearance. His snout has grown longer and much hooked; large, conical, hooked teeth have appeared in his jaws; his body has grown thinner and apparently deeper, though the latter point has not been determined yet by measurements; his skin has thickened and embedded the scales. The larger males become somewhat reddish in color as spawning time approaches. The female has changed less. The abdomen is somewhat distended from the ripening ova, the skin thickened as in the male, and the color has become more or less of a dull olive.



HEAD OF A SALMON WITH THE OPERCLE CUT AWAY, SHOWING THE GILLS ATTACKED BY FUNGUS AND PARASITIC COPEPODS. YET ALIVE WHEN TAKEN.

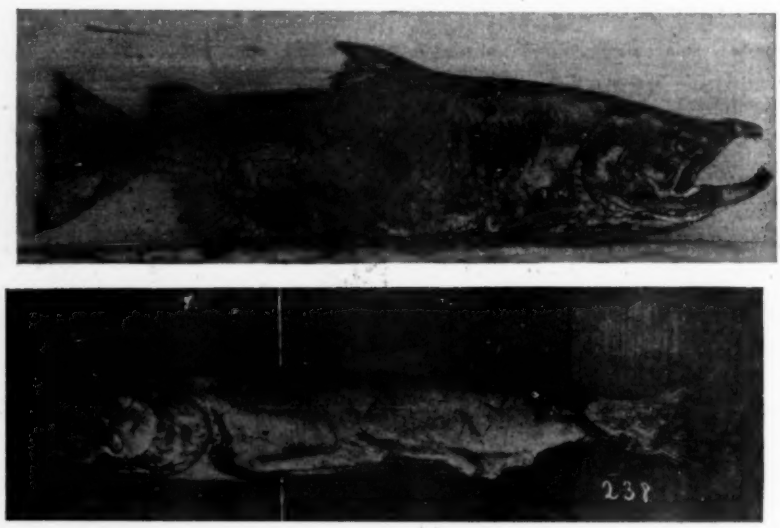
As spawning progresses, both sexes rapidly become emaciated. Their fins become frayed and worn, especially the caudal fin of the female, which is frequently entirely worn off. Fungus attacks the skin in various places, especially the top of the head and the fins, and it frequently destroys one or both eyes. The gills are nearly always



ALIMENTARY CANAL OF A SALMON TAKEN IN MONTEREY BAY.

ALIMENTARY CANAL OF A SALMON AFTER SPAWNING, TAKEN AT BATTLE CREEK FISHERY

attacked by fungus and parasitic Copepods, and half or even three fourths of the gill filaments are sometimes thus destroyed. The skin is worn off in many places, such as the side of the tail, the projecting edges of the jaws and fins, and the snout of the male. They have eaten nothing since leaving the ocean, and the alimentary canal has

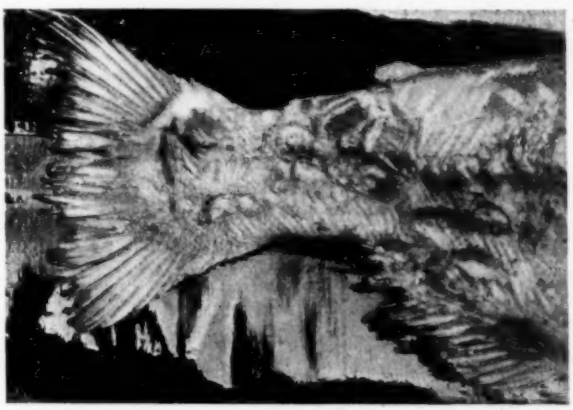


MALE AND FEMALE AFTER SPAWNING.

long since shriveled up until the stomach is scarcely one tenth its normal size; a catarrhal desquamation takes place all along the digestive tract, but especially posterior to the stomach, which portion is frequently filled with tapeworms. At least two other kinds of

parasitic worms are frequently found in the abdominal cavity. Both sexes lose from 30 to 40 per cent. of their weight.*

Such is the condition of the salmon at the time of death. It is not the spawning itself that produces this effect, but the continuation of the spawning efforts after all ova have been extruded and fertilized. Usually there is considerable vitality in both sexes at the time of the complete extrusion and fertilization of the ova, and they have enough energy left, in many cases, to carry them back to the ocean. But they exhibit no inclination to go. Instead, they continue on the spawning beds, persevering in their efforts to spawn and fertilize more eggs. When one fish of a pair dies, the other seeks or is sought by a new mate. Probably the female never notices the death of the male, as there are nearly always several males fighting around each 'nest.' If there happens to be no salmon in the vicinity when one of a pair dies, the



THE TAIL OF A SPAWNED-OUT FEMALE.

survivor continues his or her efforts alone, futile though they are.

This extreme devotion to a purpose is almost without parallel. There is no instinct whatever to return to salt water. It is even doubtful whether they would revive if taken back. The dog salmon and hump-back salmon spawn in small streams that empty directly into the ocean, and they are found dying and dead in brackish water. The fact that all salmon, of the genus *Oncorhynchus,* die immediately after spawning once cannot be questioned.

* The description here given of the spawning salmon should not prejudice any one against the fish as found in the markets, either fresh or canned. Such are taken either in salt water or within a few days after leaving it, and are in prime condition. Indeed, they must necessarily be, in order to make the long journey up the river and live several months without food. Chemical analyses have shown that the Sacramento salmon is the most nutritious of fishes.

A MODERN STREET.

By Dr. S. F. PECKHAM.
NEW YORK CITY.

A MODERN street is laid on a concrete foundation, the surface of which may consist of brick, asphalt block or sheet asphalt.

It is of the greatest importance that the foundation should be properly constructed. It is true that in cities where a large area of Belgian block pavement has been already laid, sheet asphalt is often laid upon these blocks; but while streets can be made in this way, they are, when so constructed, more or less liable to criticism in several respects; but chiefly from the fact that the Belgian block, as compared with concrete, is an unstable foundation, liable to yield under unusual or excessive strain and always sure to carry the surface with it. While this cause of the criticism is usually absent, especially upon residence streets, there have been conspicuous examples of its presence in almost every large city, where the custom of laying asphalt surfaces on Belgian block prevails. We therefore consider the normal modern street as laid on a concrete foundation.

The French engineers determined the elements of this problem, nearly half a century ago, by very costly experiments for which the city of Paris was mainly responsible. As all the roadways of France are more or less completely under governmental supervision, the results of these experiments have been described in several masterly memoirs by some very able French engineers, in the *Annales des Ponts et Chaussées,* which is the official organ of the French governmental supervision of bridges and roads. Space forbids mention here of more than a summary of these results. It was found that of all the materials that were available, only a concrete made of Portland cement of good quality mixed with clean sharp sand and broken stones was always to be depended upon. If a concrete foundation could always be laid on well drained earth properly rolled or rammed, that was never invaded by frost and never disturbed by openings for all the multitudinous purposes that disturb modern streets, concrete that will not stand such rigid tests might be used instead of that made of Portland cement. But, streets laid under such conditions and subjected to such use are an exception, indeed they are rare, and for that reason should not be made the rule. The French engineers determined that under *any* circumstances, nine inches of concrete would hold *any* traffic; that six inches

would hold up all ordinary traffic and that four inches would hold in many special cases. They adopted a thickness of six inches of Portland cement concrete as a general rule, and that rule has been followed in England and the United States with very general satisfaction.

It is imperatively necessary that this foundation should present to the material laid upon it an absolutely unyielding surface, for the reason that the bricks or blocks being jointed and the thin sheet of asphalt, while continuous, possessing very little strength in itself, either of them is bound to follow a yielding foundation with disastrous results. As before stated, an unyielding foundation is therefore, within reasonable limits, an absolute necessity; for, while the average street in our northern cities is liable to the vicissitudes of frosts, and still more liable to the vicissitudes of frequent openings, the evil effects of these vicissitudes can be for the most part avoided by constructing a concrete foundation sufficiently strong to form a bridge over any such weak spots of limited extent, and thus hold up the surface. This very obvious requirement will never be found in a concrete that is neither thick enough nor strong enough.

The action of the Commissioners of Accounts of the City of New York in insisting that only Portland cement of good quality should be used in the street foundations of Greater New York only confirmed and was confirmed by the conclusions reached by the French engineers more than a generation ago. Why such a question should have been raised at this time by engineers presumably familiar with the literature of their profession is not apparent.

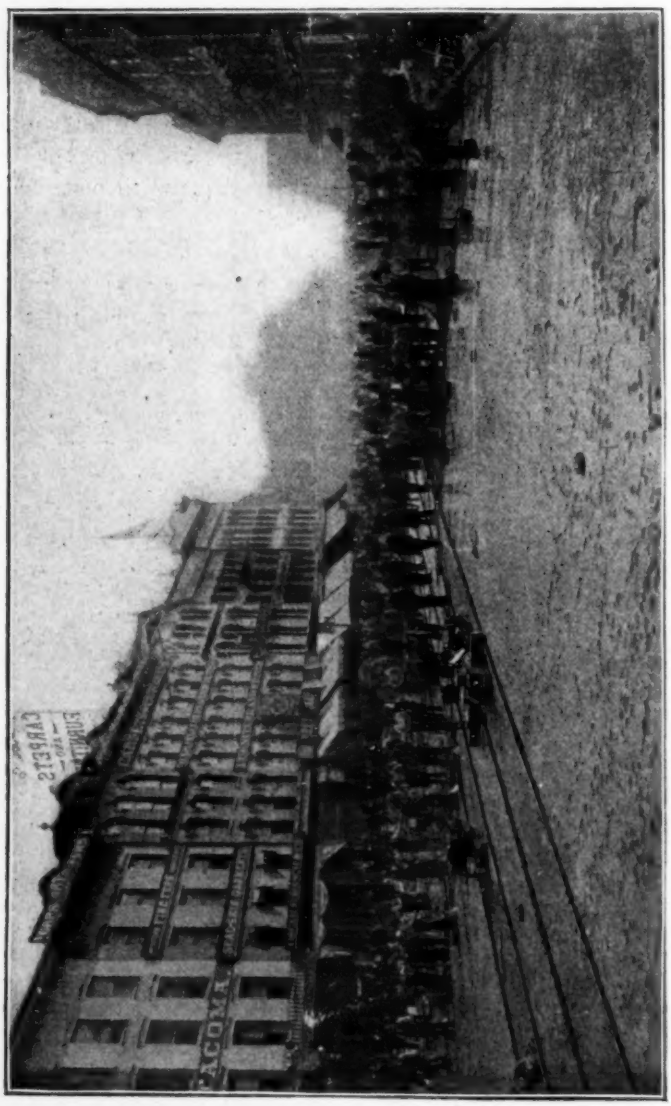
In constructing this foundation the contractor is required to proceed as follows:

> **The concrete shall be composed of one part cement, three parts of sand and six parts of broken stone. . . . Unless machinery be used, concrete shall be mixed in batches, one barrel of cement with the requisite proportion of other material, on suitable tight platforms, not less than twelve feet by twelve feet in size. The cement and sand shall be thoroughly mixed dry and then made into a mortar with as little water as possible, after which the broken stone, having first been watered, shall be added. The whole mass shall then be turned and worked until a moist resultant is obtained, with the stone uniformly distributed.**

It is very necessary that the concrete should be thoroughly set and dried out before the surface should be placed upon it. It is therefore advisable that a modern street should be constructed during dry and warm weather.

If the surface is to be of brick, a brick made especially for the purpose is used that is uniformly burned until vitrified. The size should be as uniform as possible, they should be hard enough to resist abrasion and of a texture that renders them impervious to water. When they

are laid the dry surface of concrete is swept clean and strewn with dry, clean sand, upon which the bricks are laid and pounded to the proper contour. The joints are filled either with sand or bituminous grout. In the latter case the pavement is impervious to water and the surface makes a very clean and excellent street.



WOODWORTH AVENUE, DETROIT, MICH. LAYING CONCRETE FOUNDATION.

The asphalt blocks are made of asphaltic cement and pulverized rock in the form of large bricks. The materials are thoroughly incorporated together and pressed out while hot in a sort of brick-machine

of great power, which renders the resulting block as solid as the materials can be made. The blocks are required by the specifications to be 4 x 5 x 12 inches and to vary not more than one quarter of an inch in dimensions. They are laid on their edges on a cushion of two inches of sand, so that the surface presented to wear shall be 4 x 12 inches, either in parallel rows or in a diagonal across the street. The surface, after the wear of a summer, during the heat of which it softens slightly, becomes nearly coherent and as continuous as sheet asphalt. On grades, the slight irregularities due to jointing offer a better foothold to the hoofs of horses than sheet asphalt and in this respect the asphalt blocks are the best. It is found in practice that on streets subjected to very heavy traffic, asphalt blocks are more easily broken than a good quality of sheet asphalt, but for streets that are subjected only to light traffic, asphalt block pavements are durable, clean and sightly, and cost little or nothing for repairs over long periods of time.

The larger number of so-called asphalt streets are laid with sheet asphalt, in imitation of the surface first laid about fifty years ago in France from the natural bituminous rock occurring at Pyrimont and Seyssel, near the border of France and Switzerland and near the headwaters of the river Rhone. This material consists of chalk saturated with bitumen, which, when extracted, is found to be very permanent in the air, impervious to water and very tenacious. When the bituminous rock is heated to a moderate temperature it falls into powder that can be screened to remove the flints that are in the chalk. It is then spread, while hot, with rakes, and rolled into a sheet that lasts until it wears out. This bituminous rock was called 'asphalt' by M. Léon Malo, the distinguished French engineer, through whose efforts and inventive skill the laying of these streets became an established industry in France.

M. Malo did not identify 'asphalte' as thus named by him, with asphaltum, which is the solid variety of bitumen, and had been known for an immemorial period before any one thought of using bituminous limestone in the construction of streets.

M. Malo says in his paper, published in 1861:

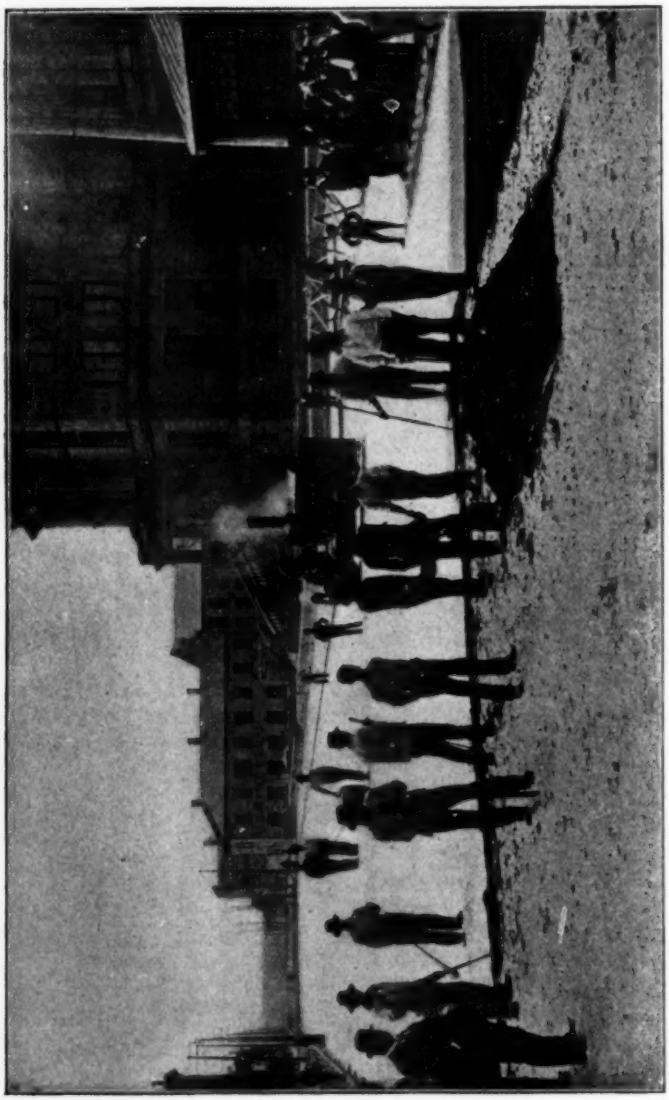
> The first point is to establish the value of the definitions and of the words.

To this end he proposes a nomenclature of which he gives the following summary:

> First, bitumen or pitch, the materials which impregnate asphalte.
>
> Second, asphalt, the calcareous rock, impregnated naturally by bitumen or pitch.

This definition gave this peculiar bituminous mineral a name that passed to the streets made from it, and these streets became known in England and the United States as 'asphalt streets.'

The great popularity of these streets in Europe led to attempts to construct similar streets in the United States. This was at first a difficult problem as at that time no bituminous limestone was known in America, and those who attempted to introduce an imitation of an



LAYING ASPHALT SURFACE, OHIO STREET, TERRE HAUTE, IND. PAVEMENT LAID 1897.

asphalt-surfaced street were forced to use such materials as were available. A number of streets were laid in Washington, D. C., of a sort of bituminous concrete, made of coal tar pitch and broken stone that was laid very thick. Some of these streets are now in existence, more

than 20 years old, and in fairly good condition. A better imitation, or what was supposed to be a better one, was made of pitch from the celebrated pitch lake of Trinidad and the liquid residuum of the petroleum stills, which was then a drug on the market. This mixture was tempered with sufficient sand to make about 90 per cent. of the mineral matter and laid, spread and rolled like the European asphalt. The experiment proving a success, the name 'asphalt street' was applied to these artificial imitations of asphalt. No harm came from this wrong application of M. Malo's word for many years, as the use of it was confined to street surfaces of which natural bitumen was the principal constituent.

About 1890, the late Joseph D. Weeks, of Pittsburg, visited the Pacific Coast and found that the petroleum refiners of California were making a solid residuum from the distillation of petroleum and calling it 'asphalt.' Mr. Weeks immediately conceived the idea that California petroleum contained 'an asphaltic base,' or in other words, it might be considered to be asphaltum dissolved in petroleum from which it could be separated by distilling off the petroleum. This very erroneous conclusion led to a second one, viz., that the residuum of the distillation of California petroleum is practically the same thing as natural asphaltum. On the contrary, these residuums of petroleum, no matter in what manner they may be made, are the product of destructive distillation and should be made the subject of prolonged and careful experiment before they are used in any considerable quantity as an equivalent for natural asphaltum.

The difficulty which M. Malo feared would follow the careless use of terms to designate the different forms of bitumen has overtaken us, inasmuch as the word 'asphalt' is now applied to a large number of the most heterogeneous substances, quite unlike in many respects, but having other properties, denominated bituminous, in common.

An enumeration of these materials will illustrate my meaning. The natural solid bitumens are M. Malo's asphalts, called in the United States rock asphalt, and including bituminous sandstones, as well as limestones, of which there are large deposits in California, the Indian Territory and Kentucky; Trinidad pitch; Bermudez, Cuban, California, Mexican and other asphaltums; Gilsonite, the bituminous coquina or shell limestone of Uvalde County, Texas, with the extracted bitumens of California and the Indian Territory. All these materials have been used successfully in making asphalt surfaced streets.

The so-called artificial asphalts, called asphalts by local application of the word, are the solid residuums of the so-called asphaltic petroleum, found in California and Texas; Pittsburg Flux, which is the residuum made by burning out the hydrogen from petroleum with sulphur; residuums made by several other patented methods and sold under various

trade names, with the solid residuums from the ordinary distillation of petroleum, all of which are very unlike natural asphalts or any imitation of them in which natural bitumen is used and among which there is great diversity of properties and qualities.

JARVIS STREET, TORONTO, CANADA. PAVEMENT LAID 1889.

To construct a street of any of these natural or artificial materials, all passing under the name of 'asphalt,' the same general method of procedure should be followed.

If the crude asphalt is to be refined, it is put into an enormous ket-

tle, or still, where it is slowly melted in order to drive off the water and light oils. Such oils make the work on the street dangerous from liability of fire. The refined pitch or asphaltum, from which an excess of mineral matter has settled or any sticks or other organic matter has been skimmed off, is drawn into barrels.

A fluid residuum of heavy petroleum or mineral tar, which has also been deprived of water and light oils, is mixed with the asphalt in the proportion of 20 parts by weight of oil to 100 parts of asphalt. It is of the highest importance that this mixture should be very complete. If the blending is imperfectly done, the oil will wash out from the asphalt after the street is laid and the surface will dry out, crack and disintegrate. This asphaltic cement should be plastic and very tenacious and should preserve these properties through a wide range of temperature. If it becomes brittle at zero or nearly fluid at or about 100° Fahr., it will not answer, as it will be brittle and break up in winter and will soften and flow in summer.

To prepare the surface mixture, an asphaltic cement possessing the proper qualities is mixed with sand and pulverized rock in such proportions that when finished it will contain about eleven per cent. of bitumen. The proportions depend upon the kind and quality of the crude bitumen, the locality in which the street is to be laid and the traffic to which it will be subjected. The sand should be clean and sharp and should consist of both fine and coarse particles in such proportions that the fine particles will fill the voids between the coarse particles, leaving the bitumen to hold all of the particles together.

Every element in the construction of an asphalt-surfaced street is important if the result is to be in every respect a durable and satisfactory street. No part can be slighted or neglected in either materials or workmanship. If the street is to be first class each and all of these must be first class of its kind.

The material and drainage of the sub-soil is of the highest consequence. Water is a great enemy to asphalt streets, particularly to those constructed of Trinidad pitch. It is therefore of the greatest importance that the subsoil on which the concrete foundation is laid should be as solid and dry as possible. All excavations made in the subsoil should be puddled and rammed, in order that the rolling may result in a perfectly uniform and unyielding surface.

Of equal importance is a proper concrete foundation. It should not only be sufficiently strong, but it should be as impervious to water as possible. Soft, spongy foundations of natural cement or Portland cement of inferior quality are not only an inadequate support for the yielding surface, but they are easily penetrated by water from below and act as conveyors of water, while a sound and firm foundation of the best Portland cement concrete not only presents an unyielding support

to the surface, but also, when properly set and dried before the surface is laid, keeps the surface as free as is possible under the circumstances from ground water, and thus contributes to the longevity of the surface.

CASS AVENUE, DETROIT, MICH. PAVEMENT LAID 1889, SHOWING STREET-CLEANING UNDER THE 'ORDERLY SYSTEM.'

The concrete surface, having been laid as nearly as possible of the proper contour, and having been thoroughly set, dried out and swept clean, is covered with a binder course to fill the inequalities of the concrete and form a bond between the concrete and surface that will

not only attach the surface to the concrete, but will hold the surface in place and keep it from sliding from the center towards the gutters. The binder consists of small broken stone, which should be sound and clean. Each piece should be completely covered with a soft asphaltic cement containing more residuum oil than the surface mixture. The stone and cement should be thoroughly mixed by machinery at a temperature that will render the bitumen perfectly fluid, but not sufficiently high to burn or otherwise injure it. It is then dumped into carts and carried to the streets, where it is spread with hot rakes, and rolled to the proper contour.

The binder is an important part of an asphalt street surface, and should be carefully compounded and laid. If it is deficient in bitumen, it will absorb bitumen from the surface, causing the surface to crack and disintegrate. If it is well supplied with bitumen that is not too soft, the surface is preserved from becoming too dry by absorbing bitumen from the binder, or, in the technical phrase of the art, 'is nourished from the binder.'

The binder being laid and rolled presents a surface that should be exactly parallel to the surface of the finished street. Upon this surface the surface mixture of asphaltic cement and sand is brought in carts, while still hot, and is spread also with hot rakes and rolled, first with hand rollers and finally with heavy steam rollers, until cold. The rollers are prevented from sticking by strewing the surface with hydraulic cement or fine sand. The rolling is an important element of a good asphalt-surfaced street, as upon that depends the complete solidity of the surface mixture.

As both good and bad streets have been made of about every variety of natural bitumen in the form of asphalt or asphaltum that can be had, the quality of a street appears to depend quite as much upon the technical skill of those who lay the street as upon the kind of material of which it is constructed. Of the various substitutes now being offered for natural bitumens too little has been demonstrated by use to warrant any conclusions concerning them.*

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* I wish herewith to express my obligations to the Warren-Scharf Asphalt Paving Company for the illustrations accompanying this article.

VIEWS OF DR. RIZAL, THE FILIPINO SCHOLAR, UPON RACE DIFFERENCES.*

PROFESSOR BLUMENTRITT, the German ethnologist, was a friend of Dr. Rizal, the famous and lamented Filipino scholar and ethnologist, and after his death published an account of his life and studies in the *Internationales Archiv für Ethnographie* (Bd. X., Heft II.), together with his views upon the comparative intellectual endowments of the white and colored (Filipino) races. A translation of portions of that paper is presented here. It is a curious and pathetic spectacle which is presented in the sketch—that of a cultivated Filipino making comparative studies of himself and the domineering whites in order to discover the cause of their assumption of superiority, yet conscious all the while of the hopelessness of protesting against fate.

Incidentally the study is instructive as illustrating the natural bent of Filipinos for higher studies, a feature of their character which is ignored by the American newspaper writers, who have in mind, apparently, when speaking of education in the Philippines, only the elementary studies taught in the public schools of the United States.

The anniversary of the execution of Dr. Rizal is observed in the Philippines, both by the native public and in the schools, where the day is known as Rizal day. It is a singular fact, and perhaps one significant of some trait in the character of the race, that the national hero of the Tagals was neither a military man nor a politician, but a man of intellectual gifts, and a student, who devoted his talents to his country and became a martyr to its cause. [Tr.]

Professor Blumentritt writes as follows:

On December 30, 1896, the Spanish authorities in Manila shot to death the greatest son of the Philippines, Dr. José Rizal, ostensibly because he had been an instigator of the insurrection then in full blast in the archipelago. Dr. Rizal was a Tagal, born in Calamba, a small city in the province La Laguna de Bay in Luzon. He was originally intended for the priesthood, but his own tastes inclined him to medicine and he accordingly studied that science in Manila and Madrid, at which latter university he took the degree of doctor of medicine and philosophy. He continued his medical studies in Paris, Heidelberg, Leipzig and Berlin, and also devoted himself to linguistic and ethnographical investigations, being made in consequence a member of the

* Translated by R. L. Packard, Washington, D. C.

Anthropological Society of Berlin. Upon returning to his native land he was soon compelled to emigrate because his novel 'Noli me Tangere'* had drawn upon him the unextinguishable hatred of the Old Spanish party. After a short sojourn in Japan and North America, he established himself in London where, under the guidance of Dr. Rost, he broadened his acquaintance with languages, and meanwhile edited the second edition of the well-known work of DeMorga upon the Philippines which was published in Paris.† In Biarritz, Paris, Ghent and Brussels he wrote his second political novel 'El Filibusterismo.' He then returned to the East and practised medicine for some time in Hong Kong, from which city he removed to British Borneo with a view to establishing a Filipino farming colony there. He meanwhile obtained permission to visit his home again, but was arrested upon his arrival upon the charge that anti-Spanish writings had been found in his trunks at the Custom House. He was thereupon banished to Dapitan in the island of Mindanao, whence he could easily have made his escape, but in the full consciousness of innocence he did not hesitate to remain there in exile. When the insurrection of 1896 broke out he was immediately charged with instigating it, was brought to trial on this charge three times in five months, was acquitted twice, but the third time his unchristian enemies succeeded in their purpose of convicting him and he was condemned to death.

Rizal devoted himself particularly to the analysis of the sentiments with which whites and the colored races mutually regard each other. No one was so well qualified as he to study this question which is of such importance for folk-psychology, for he was himself of a colored race, had lived among his fellow countrymen at his own home, as well as among the whites, mixed bloods and other classes at Manila, and had besides come to know Hong Kong, Japan, Europe and the United States, and that in a thorough way and not as a mere tourist. His extensive acquaintance with languages opened for him the ethnological writings of all civilized nations, and his own penetrating intellect prevented him from remaining content with the surface of things. It should be said, however, that Rizal concerned himself wholly with the relations between the whites and the colored people of the Philippines because, as he explained, he knew nothing of the psychology of other colored races.

He said that when a boy he was deeply sensible that the Spaniards treated him with contemptuous disregard for the sole reason that he was a Filipino. From the moment when he discovered this attitude

* Published in an English translation in the United States under the title 'An Eagle Flight.'

† De Morga was viceroy in Manila in 1598 and wrote a most valuable work upon the Philippines which was published in Mexico in 1609.

of theirs he endeavored to find out what moral right the Spaniards, and the whites generally, had to look down upon people who think as they do, study the same things they study, and have the same mental capacities they possess, simply because these people have a brown skin and stiff straight hair.

Europeans regard themselves as the sovereign masters of the earth, the only supporters of progress and culture and the sole legitimate species of the genus *Homo sapiens,* while they proclaim that all other races are inferior, by refusing to acknowledge their capability of acquiring European culture, so that, according to the European view, the colored races are varieties of the genus *Homo brutus.* Rizal then asked himself, Are these views just? He began asking this question when he was a school boy and at the same time began to answer it by observing his white fellow students closely while he studied his own mental processes and emotions in order to make comparisons. He soon remarked that, in school at least, no difference could be detected between the intellectual level of the whites and Filipinos. There were lazy and industrious, moral and immoral, dull and intelligent boys among the whites as well as among the Filipino scholars. Soon this study of race spurred him to exert himself to the utmost in his school studies and a kind of race rivalry took possession of him. He was overjoyed whenever he succeeded in solving a difficult problem which baffled his white companions. But he did not regard these events as personal successes so much as triumphs of his own collective people. Thus it was in school that he first became convinced that whites go through the same intellectual operations as Filipinos and—*ceteris paribus*—progress in the same way and to the same extent. From this observation he came to the conclusion that both whites and Filipinos have the same natural intellectual endowment.

In consequence of this conclusion there manifested itself in Rizal, as he himself avowed, a sort of national self-exaltation. He began to believe that the Tagals must stand higher intellectually than the Spaniards (the only whites he had known up to that time), and he used to like to tell how he came to this fallacious conclusion. In the first place, he said, in his school the whites received instruction in their own language while the Filipinos had to worry with a strange idiom in order to receive instruction which was given in it alone. The Filipinos therefore must be better endowed intellectually than the Spaniards, he inferred, since they not only kept up with the latter in their studies but even surpassed them, although handicapped by a different language. Still another observation caused him to disbelieve in the superiority of the European intelligence. He noticed that the Spaniards believed that the Filipinos looked up to them as beings of a superior nature and made of a finer clay than themselves. But Rizal knew very well that

the respectfulness which the Filipinos manifested towards the Spaniards did not proceed from self-depreciation, but was simply dictated by fear and self-interest. By fear, because they saw in the Spaniard their lord and master who oppressed them arbitrarily even if with good intentions; by self-interest, because they had observed that his pride of race lays the European open to flattery and that they could get large concessions from him by a little subserviency. The Filipinos do not, therefore, have any real respect for the European, but cringe and bow to him from interested motives alone. Behind his back they laugh at him, ridicule his presumption and regard themselves as in reality the shrewder of the two races. Because the Spaniards never divined the real sentiments of the Filipinos towards themselves, young Rizal felt justified in regarding them as inferior in intelligence to his own countrymen. But in later years he found it necessary to change this false impression of his youth, especially as he had found by his own personal experience how easy it is to draw mistaken conclusions about people of a different race from one's own. "Whenever," he used to say, "I came upon condemnation of my people by Europeans, either in conversation or in books, I recalled those foolish ideas of my youth, my indignation cooled, and I could smile and quote the French proverb '*tout comprendre c'est tout pardonner.*'"

Dr. Rizal's sojourn in Spain opened to him a new world. His intellectual horizon began to widen with his new experiences. New ideas thronged in upon him. He came from a land which was the very home of bigotry, where the Spanish friar, the Spanish official and the Spanish soldier governed with absolute sway. But in Madrid he found the exact opposite of this repression. Free thinkers and atheists spoke freely, in disparaging terms, of religion and the church; the authority of the government he found to be at a minimum, while he not only saw liberals contending with the clerical party but he beheld with astonishment republicans and Carlists openly promoting the development of their political ideas.

Still greater was the influence upon him of his residence in France, Germany and England. In those countries he enlarged his scientific information, or it would be better, perhaps, to say that there the spirit of modern philology was revealed to him, and there he learned the meaning of the word ethnology.

The personal influence of the late Dr. Rost, of London, was most marked in the philological training of Dr. Rizal. His teachings and the study of the works of W. v. Humboldt, Jacquet and Professor H. Kern opened a new world for the Filipino scholar. He formed a plan to write a work upon the Tagalog verb, which he afterwards modified and, while in exile in Dapitan in Mindanao, he began to write a Tagalog grammar

in English and at the same time prepared an essay upon the allied elements in the Tagalog and Visayan languages. The former work he intended to dedicate to Professor Kern in the name of the Malay race, the latter he wished to inscribe to the memory of Dr. Rost. It was not granted to him to complete the manuscript of either, for he was interrupted in the midst of his work to be dragged about from tribunal to tribunal until his final sentence and death by public execution.

Fortunately his work upon the transcription of Tagalog remains to us, a translation having appeared in the *Bijdragen* of the Indian Institute. Unfortunately this work only increased the hatred of his political opponents, for the Spaniards were bitterly opposed to any independent work on the part of the Filipinos, being convinced that everything of the kind was merely a cloak for separatist views, and whoever was suspected of separatism in the Philippines was certain of meeting an unhappy fate.

Rizal, brought up among Spaniards, was no better instructed than they themselves in modern ethnology and, indeed, it was through Professor Blumentritt's instrumentality that his attention was first directed to the defects in his education in that direction, whereupon he began with ardor to enlarge his knowledge in comparative ethnology. The works upon general ethnography by Perschel, F. Müller, Waitz, Gerland and Ratzel, the ethnographical parallels of Andrée, Wilkin's works, the culture-historical publications of Lippert and Hellwald became at once the subject of his industrious and thorough study, a study, furthermore, which not only enlarged his knowledge but afforded him the consolation of the assurance that his people are not an anthropoid race as the Spaniards asserted, for he found that the faults and virtues of the Tagals are entirely human, and, moreover, he became convinced that the virtues and vices of any people are not mere peculiarities of race but are inherited qualities, qualities which become affected by climate and history.

At the same time he continued what he called his 'course in practical ethnology,' that is to say, he studied the life of the French and German peasantry because he thought that a peasantry preserves national and race peculiarities longer than the other classes of a people, and also because he believed that he ought to compare only the peasantry of Europe with his own countrymen because the latter are nearly all peasants. With this object in view he withdrew for weeks and months to some quiet village where he observed closely the daily life of the country people.

He summed up the results of his scientific and 'practical' studies in the following propositions:

1. The races of mankind differ in outward appearance and in the structure of the skeleton but not in their psychical qualities. The same

passions and pains affect the white, yellow, brown and black races; the same motives influence their action, only the form in which the emotions are expressed and the way the actions are directed are different. Neither is this particular form of conduct and expression constant with any race or people, but varies under the influence of the most diverse factors.

2. Races exist only for the anthropologists. For a student of the customs of a people there are only social strata, and it is the task of the ethnologist to separate and identify these strata. And just as we mark out the lines of stratification in the mountain ranges of a geological sketch so ought we to mark out the social strata of the human race. And just as there are mountains whose summits do not reach to the highest strata of the geological system, so there are many people who do not reach the highest social strata, while the lowest strata are common to all of them. Even in the old established civilization of France and Germany a great proportion of the population forms a class which is upon the same intellectual level with the majority of the Tagals, and is to be distinguished from them only by the color of the skin, clothing and language. But while mountains do not grow higher peoples do gradually grow up into the higher strata of civilization and this growth does not depend upon the intellectual capacity alone of a given people, but is also due, to some extent, to good fortune, and to other factors, some of which can be explained and others not.

3. Since not only the statesmen who conduct colonial affairs but scientific men as well maintain that there are races of limited intelligence who could never attain the height of European culture, the real explanation must be as follows: The higher intelligence may be compared to wealth—there are rich and poor peoples just as there are rich and poor individuals. The rich man who believes that he was born rich deceives himself. He came into the world as poor and naked as his slave, but he inherits the wealth which his parents earned. In the same way intelligence is inherited. Races which formerly found themselves compelled, by certain special conditions, to exercise their mental powers to an unusual extent, have naturally developed their intelligence to a higher degree than others, and they have bequeathed this intelligence to their descendants who, in turn, have increased it by further use. Europeans are rich in intelligence but the present inhabitants of Europe could not affirm, without presumption, that their ancestors were just as rich in intelligence at the start as they themselves are now. The Europeans have required centuries of strife and effort, of fortunate conjunctions, of the necessary liberty, of advantageous laws, and of individual leading minds, to enable them to bequeath their intellectual wealth to their present representatives. The

people who are so intelligent to-day have become so through a long process of transmission and struggle. History shows that the Romans thought no better of the Germans than the Spaniards do of the Tagals, and when Tacitus praises the Germans he does so in the same spirit of philosophical idealizing which we see in the followers of Rousseau who thought that their political ideal was realized in Tahiti.

4. The condemnatory criticism of the Filipino by Spaniards is easy to explain but appears not to be justified. Rizal demonstrates this in the following way: Weaklings do not emigrate to foreign lands but only men of energy who leave home already prejudiced against the colored races and reach their destination with the conviction, which is usually sanctioned by law, that they are called to rule the latter. If we remember, what few white men know, that the Filipinos fear the brutality of the whites, it is easy to explain why they make such a poor showing in works written by the latter while they themselves can not reply in print. If we consider, further, that the Filipinos with whom the whites have dealings belong, for the most part, to the lower strata of society, the opinions of them given by the whites have about the same value as that of an educated Tagal would have who should travel in Europe and judge all Germans and French by the dairy maids, porters, waiters and cabdrivers he might meet.

5. The misfortune of the Filipinos is in the color of their skin and in that alone. In Europe there are a great many persons who have risen from the lowest dregs of the populace to the highest offices and honors. Such people may be divided into two classes, those who accommodate themselves to their new position without pretensions, and whose origin is consequently not reckoned to them as a disgrace, but on the contrary they are respected as self-made men; and the conventional parvenus who are ridiculed and detested universally.

A Filipino would find himself ordinarily in the second of these two classes, no matter how noble his character or how perfect a gentleman he might be in his manners and conduct, because his origin is indelibly stamped upon his countenance, visible to all, a mark which always carries with it painful humiliations for the unfortunate native, since it forever exposes him to the prejudices of the whites. Everything he does is minutely criticised, a trifling error in etiquette which would be overlooked in a shoemaker's son who had acquired the title of baron, and which might easily happen to a pure-blooded descendant of the Montmorencys, in his case excites amusement, and you hear the remark 'What else can you expect? he is only a native.' But even if he does not infringe any of the rules of etiquette, and is besides an able lawyer or a skillful physician, his accomplishments are not taken as matters of course but he is regarded with a kind of good-natured surprise, a feeling much like the astonishment with which one regards

a well-trained dog in a circus, but never as a man of the same capabilities as a white man.

Another reason for the mean opinion in which the Filipinos have been held by the whites is found in the circumstance that in the tropics all the servants are colored. They have the defects of their social class and of servants everywhere. Now when a German housewife complains of her servants she does not extend their bad qualities to the whole German nation, but this is done unblushingly by Europeans who live in the tropics, and they never, apparently, feel any compunctions, but sleep the sleep of the just, undisturbed by conscience.

The merchants also have contributed to the unfavorable judgment of the Filipinos. Europeans come to the tropics in order to get rich as soon as possible, which can only be done by buying from the natives at astoundingly low rates. The latter, however, do not regard this proceeding as a really commercial one, but they believe that the whites are trying to cheat them, and they govern themselves accordingly by trying, on their side, to overreach the whites, while their dealings with one another are far more honorable. Consequently the Europeans call the natives liars and cheats while it never occurs to them that their own exploiting of the ignorance of the natives is a conscienceless proceeding, or rather they believe that, as whites, they are morally justified in dealing immorally with the natives, because the latter are colored.

Dr. Rizal finally came to think that he need no longer wonder at the prejudices of the whites against his people after he saw in Europe what unjustifiable prejudices European nations entertain against one another. He himself was always benevolent and moderate in his judgment of foreign peoples. His active and keen mind, his personal amiability, his politeness and manner as a man of the world, and his good and noble heart gained him friends everywhere, and therefore the tragic death of this intellectually distinguished and amiable man aroused general concern.

Rizal was an artist of delicate perceptions, a draughtsman and sculptor, as well as a scholar and ethnologist. Professor Blumentritt possesses three statues made by him of terra cotta, which might aptly serve as symbols of his life. One represents Prometheus bound; the second represents the victory of death over life, and this scene is imagined with peculiar originality; a skeleton in a monk's cowl bears in its arms the inanimate body of a young maiden. The third shows us a female form standing upon a death's head and holding a torch in her high uplifted hands. This is the triumph of knowledge, of the soul, over death.

Rizal, concludes Professor Blumentritt, was undoubtedly the most distinguished man not only of his own people but of the Malay race in general. His memory will never die in his fatherland. He never was an enemy of Spain.

GOLD MINING IN KLONDIKE.*

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MY visit to Klondike took place at the end of August, 1901, at a very interesting time, and under most favorable conditions. The journey was made at the invitation of the Hon. Clifford Sifton, Canadian Minister of the Interior, and in company with Professor Coleman, of Toronto. Mr. Sifton provided us with a most efficient military escort in the person of Captain Strickland of the Northwest Mounted Police, who possesses an intimate knowledge of the far Northwestern Territory and its inhabitants. Consequently, we were able in a short visit to see a great deal and to become acquainted with the leading features of the mining industry.

The time was particularly interesting, because in 1901 the conditions of life were still to a large extent those of a young mining camp, but were undergoing rapid transformation into the social and political conditions of an organized and civilized community.

Access to Klondike is now practically confined to a single route available for the ordinary traveler. It is true that a considerable amount of merchandise is taken in by the sea and river route which consists of a voyage (from Seattle) of 2,700 miles by sea to St. Michaels at the mouth of the Yukon, followed by a voyage of 1,370 miles up that mighty river to Dawson City—a total of about 4,000 miles. But the ordinary passenger route is the following:—a sea voyage of 900 miles, up the quiet waters that lie between the islands and the mainland, from Vancouver to the little American port of Skagway; a journey of 112 miles across the coast range, by the newly constructed White Pass and Yukon railway, to the little town of White Horse on the Yukon; and a voyage of 450 miles down the Yukon from White Horse to Dawson City in a stern-wheel steamer—a journey of only 1,460 miles in all. By this route the sea voyage occupies from three to five days, the railway journey about twelve hours, and the river voyage from two to three days.

The railway climbs the icy precipices of the coast range, and crosses into Canadian territory at the summit of the famous White Pass which earned so unenviable a reputation as the scene of disasters and deaths during the great rush into the country in the winter of

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1897; and the traveler is brought down to the banks of the Yukon just low enough to escape the terrible White Horse Rapids, where also so many lives were lost in those early days. The voyage hence to Dawson is a quick one, with a stream whose average current is five miles an hour.

Dawson City, which in 1898 was only a collection of huts on a frozen mud swamp situated at the point where the Klondike River enters the Yukon, is now a town of about 10,000 inhabitants, consisting, it is true, of wooden buildings and chiefly of log cabins, but possessing hotels, clubs, theaters, saw-mills, large stores, electric light, telephones, power works and all the resources of modern civilization. New government buildings were rising at the time of my visit, and the town wore an aspect of considerable and prosperous activity.

It is interesting to watch the life of this remarkable city, situated 1,500 miles from Vancouver and close upon the Arctic circle: upon the plank sidewalks are slouch-hatted, long-booted miners who throng dance-halls and saloons and pay from pouches of gold-dust; busy merchants, traders and storekeepers of all nationalities; well-dressed ladies and children; military men, surveyors, engineers and lawyers; while in the dusty roadway are to be seen men riding long-tailed horses with Mexican saddles, driving pack-mules laden with boxes, or urging yelping teams of dogs with the cry 'mush, mush.'

Popular accounts of this country generally represent it in its winter dress of snow, and relate tales of the rigorous severities of the Arctic frost. At the time when I was there Dawson was enjoying the mild and equable climate which prevails in the summer months, when the temperature may even rise to 90° F.; no snow was visible save that which clothed the serrated peaks of the northern Rockies, and their majestic chain was only to be seen from the summit of Moosehide Mountain above Dawson, and at a distance of about 40 miles to the north. The inhabitants had begun to grow potatoes, cabbage, lettuce and other vegetables, and a considerable market garden was being laid out on the left bank of the Yukon. And yet there is one remarkable feature of the country which prevents the traveler from ever forgetting that he is close upon the Arctic circle; if a hole be dug only three feet deep at any spot in the boggy ground, it will be found permanently frozen at that shallow depth; even in Dawson itself the log cabins rest upon a foundation of ice which never thaws.

There is also a striking feature of life in Dawson which ever reminds the visitor that he is in a mining camp. He will have to pay 1s. or 2s. for a bootblack or a barber, 2s. for a glass of cow's milk, 6s. for three boiled eggs or a mutton chop, 30s. for a bottle of claret, perhaps £20 a day for the hire of a rig and team of horses. The rent of a log cabin is about £120, and a sense of economic insecurity is

inspired by the fact that the rent of a house is about half its value, and that 60 per cent. is an ordinary rate of interest for loans. Laborers' wages are £2 a day. Although almost anything required may be purchased in Dawson, all goods have been imported at great expense into a country which of itself has produced nothing but gold and wood. The freight rates on the White Pass route are about six cents a pound, and £23 a ton may be paid from Vancouver to Dawson.

The mining camp is situated to the southeast of Dawson at a distance of about thirteen miles. The productive area is about thirty miles square, and is bounded on the north by the Klondike River, on the west by the Yukon River, and on the south by the Indian River. The district is a gently undulating upland or plateau, attaining an average height of nearly 3,000 feet above the Yukon, and intersected by deep flat-bottomed valleys which radiate from its central and highest point, a rounded hill named the Dome. The valleys are separated by hog-backed ridges; the whole district is fairly thickly wooded with spruce and poplar except on the summits of the ridges; the bottoms of the valleys are occupied by flat marshy bogs, and the streams are rarely more than ten feet broad. The bog, which is from five to ten feet thick, is frozen at a short depth below the surface and keeps the underlying gravel, which may be from ten to thirty feet thick, permanently frozen right down to the bed-rock.

The principal streams are known as creeks; the short steep tributaries which flow into them as 'gulches'; and the streamlets which feed these as 'pups.' The most important creeks are from seven to ten miles in length, and are productive over perhaps half their course, so that there may be about fifty miles of richly productive gravel in the district. I was informed that one stretch of three and one half miles on El Dorado Creek produced no less than £6,000,000 of gold.

Recently constructed government roads lead from Dawson to the camp and connect the various creeks; they were being completed at the time of our visit, and were still very rough or almost impassable at some points among the creeks; numerous rudely built but fairly comfortable 'road-houses' afford lodging to the traveler. A small town of log cabins, known as Grand Forks, has sprung up at the junction of the two most famous creeks, Bonanza and El Dorado, and is inhabited by perhaps 1,200 miners and others. There is another small town named Cariboo on Dominion Creek.

The creeks no longer present the dreary appearance of bog and forest, which made them look so unpromising to the early prospectors; the hillsides have been largely stripped of their timber, and the valley bottoms are in many parts the scene of active mining operations and rendered unsightly by machinery; the mining is also carried on upon the hillsides at a height of 300 or 400 feet, where

numerous adits penetrate the white gravel, and are marked by long heaps of tailings which descend from them towards the creek.

What little is known of the geology of the Klondike district can be stated in a few words. The auriferous area is occupied by Palæozoic schists, which may be roughly distinguished as grey or green chlorite-schist and mica-schist, and a light colored or white sericite-schist. These are bounded on the north—upon the right bank of the Klondike River—by a mass of diabase and serpentine, which constitutes the Moosehide Mountain; and on the south—on the left bank of the Indian River—by a series of quartzitic slates, schists and crystalline limestones.

The auriferous creeks are entirely situated in the micaceous schists, which constitute the bed-rock everywhere. Mr. McConnel, the government geologist, regards these schists as having originated from quartz-porphyry and other eruptive rocks, but they have been much crushed and altered and entirely recrystallized from their original condition. They are intersected by numerous bands and bosses of more recent eruptive rocks—quartz-porphyry, rhyolite, augite-andesite, diorite, basalt, etc.—and also by numerous quartz veins. In the northern and northwestern portions of the area occupied by these Klondike schists, are both broad and narrow bands of a black graphitic schist, which can sometimes be traced across the valleys.

The veins and stringers of quartz which are so frequent throughout the district have for the most part a very barren appearance, but they are sometimes mineralized to a small extent and contain a little iron pyrites, argentiferous galena, and—very rarely—gold.

Up to the present, however, the gold has been exclusively won from the gravels in the valleys, and not from the quartz veins.

The gravels are mainly of two sorts:—(1) those which constitute the floors of the present valleys and have been laid down by the present streams; (2) those which cover terraces upon the sides of the valleys and represent old valley gravels which have been cut through by the present streams.

The gold mining was at first carried on entirely in the lower gravels, and it was in them that the precious metal was first discovered. These are sandy gravels consisting of pebbles of quartz and schist—in fact, they are made up of the same materials as the bed-rock, and contain nothing that might not have been derived from the breaking up of the rocks of the district. There is no reason to believe that they were derived from any other source, and some of the pebbles are so lightly rounded that they have clearly not traveled far. Among the minerals which I have seen from these gravels are hæmatite, rutile, pyrites, graphite, cyanite, garnet, cassiterite, epidote and tourmaline; also barytes and mispickel.

The gold is very unevenly distributed in the gravel. The richest patches of pay-gravel seem to occur about half way down the valley. In the wider portions of the valleys the pay-streak may be sometimes on one side and sometimes on the other, following no doubt the former course of the stream.

The valley gravel is generally from ten to thirty feet thick, and is overlaid by from five to fifteen feet of frozen bog, locally known as 'muck.'

The hillside gravel is a very remarkable deposit; it consists almost entirely of boulders and pebbles of quartz and of sericite-schist, and, when it is exposed to view, presents the appearance of a uniform white ledge running horizontally along the hillside at a height of about 700 feet above the level of the Klondike River. It sometimes attains a depth of 120 feet, and may be as much as half a mile wide. The pebbles are to a large extent subangular and less worn than those of the valley gravels.

The early miners of course confined their attention to the valleys, and the discovery of these rich deposits upon the hillsides excited great surprise; they now rival the valley gravel in importance. The deposit is locally known as 'white-wash' or the 'White Channel.'

The origin of the White Channel is shrouded in mystery; it was at first supposed to be a glacial deposit; but there are no striations or other signs of glacial action, and it is now the opinion of the local geologists that it was laid down by the sudden inrush of tumultuous streams acting over a small area. The materials have clearly not been transported far, and the gold is even more nuggety and less worn than that of the valleys.

One is naturally led to inquire whether all the gold of the lower gravels was not brought down by streams cutting through the White Channel which occupied the bed of the valleys when they were broad and shallow, so that the White Channel may be the real source of the gold. This view is supported by the fact just mentioned that the gold of the valleys is more worn than that of the hillside, also by the fact that the valleys are richer in their central portions, which must have been covered by the White Channel, than in the upper parts which are above the level of that deposit.

Still there is no reason to doubt that the White Channel itself is of local origin: its materials are those of the district, and have not traveled far. (There are a few gravels in this area which consist of pebbles foreign to the district, and they are not auriferous.) The White Channel itself follows the present valley courses. On the whole therefore although the origin of this peculiar deposit is obscure, there can be no doubt, in my opinion, that the conclusion forced upon us by a glance at the map is correct, and that the gold has been derived from

the limited area intersected by the auriferous creeks which radiate from the Dome.

Some of the gold adheres to quartz, which exactly resembles that of the veins in the adjoining schists; and it is fairly certain that the metal came from quartz veins in the Klondike schists.

On the other hand it is certainly most remarkable that so little auriferous quartz has been found; at the time of my visit hundreds of quartz claims had been staked, but very few had been shown to contain any gold whatever; neither do the quartz boulders of the White Channel appear to be auriferous, or even mineralized. And yet it can hardly be doubted that where the valley gravels are rich in gold above their intersection with the White Channel the metal must have been derived from quartz veins in the schists.

In one instance I found direct evidence bearing on this question. In Victoria Gulch, a streamlet which descends into El Dorado Creek on its left bank high up the valley, have been found small flat crystals of gold of peculiar shape known as 'spinel twins.' In visiting a quartz vein at the head of Victoria Gulch (near the summit of the divide between El Dorado and Bonanza creeks), which had been lately opened and found to contain visible gold, I noticed precisely similar crystals. Here, at any rate, there can be little doubt that the gold in the creek has been derived from quartz veins in the schist.

No crushing has yet been carried on in Klondike; the gold has been entirely won by washing the gravels.

The chief difficulties of Klondike mining are due to the permanently frozen ground, which has led to certain peculiarities in the methods adopted. Every yard of gravel which is sluiced must first be thawed, either by artificial means or by exposing it to the rays of the summer sun after stripping off the overlying muck; for it is impossible to work the frozen ground with pick or spade, or even with dynamite.

Until recently shafts were sunk or tunnels were driven by laboriously thawing the ground with hot stones or wood fires; and I saw both methods in operation during my visit. The latter process—fire-setting, as it is called—is, in fact, quite frequent. A layer of dry wood is piled up against the face of the gravel, blanketed behind by a layer of green wood, ignited, and allowed to burn itself out; twelve hours of burning would thaw out little more than one foot in depth; and the process is then repeated.

Upon the larger properties this method has been entirely replaced by 'steam-thawing.' In this four- to six-foot lengths of iron piping, tipped with steel nozzles, are inserted into the gravel, and steam is forced through them at a pressure of about 120 pounds. These pipes are known as 'points'; one point is inserted to about each square yard, and is driven in gradually by taps from a hammer; each point will thaw

from two to five cubic yards of gravel. As contrasted with fire-setting, the steam-thawing obviates the suffocating fumes of burning wood, or the danger of thawing the frozen roof in underground workings.

A recent innovation which I saw coming into operation was thawing with water by means of the pulsometer pump, which seems to be economical since the water can be used over and over again; this process seems likely to come into more general use.

The gravel is raised from the shaft in buckets by windlass or steam-hoists, and in winter is dumped on to heaps for summer work, or in summer may be emptied straight into the sluice-boxes.

Much ingenuity has been exercised in the construction of self-dumping hoists, in which, by a single rope, the bucket is raised from the bottom of the shaft, caught by a traveling clutch, carried along a horizontal rope to the dump-heap or the sluice-boxes, where it is automatically tilted. All this is done by an engine in charge of one man, and saves much labor.

As regards the washing of the gravel, the old-fashioned hand-rockers are still to be seen in operation upon many of the gulches, but have been for the most part replaced by sluice-boxes. These are long wooden troughs made in 12-foot lengths and about ten inches broad; the bottom is lined with wooden riffles, consisting generally of longitudinal bars (Pole riffles), but sometimes of transverse bars (Hungarian riffles), by which the gold and heavy minerals are caught. Sometimes Auger riffles—planks with circular holes—are employed; mercury is seldom used. A sluice-head of 75 miners' inches, *i. e.*, 112 cubic feet of water per minute, is usual, and a fall of about eight inches in the 12-foot box length.

Water, which is very scarce in the district, and must be used economically, is conducted to the sluice-boxes by long wooden flumes, which are themselves a serious expense on account of the cost of wood (about $110 a thousand feet). Some of these flumes are half a mile in length; in a wide valley, where the pay-streak is on the opposite side from the stream, it is necessary to raise it by centrifugal pumps to a height of 30 or 40 feet, and to convey it across the valley by a long flume.

In the final 'wash-up,' by which the gold-dust is extracted from the sluice-boxes, the riffles are taken out, and a copious stream of water is sent down, which carries away the fine gravel and leaves the gold, and a heavy black sand which accompanies it. This black sand consists mainly of magnetic ore, and it is removed partly by a magnet and partly by shaking with the hand and blowing with the mouth in a small metal tray.

The mining operations on the creeks and upon the hillsides are somewhat different. On the creek a shaft is sunk down to bed-rock,

four lateral tunnels are driven from the shaft along the surface of the bed-rock, and opened out in a fan-like manner to the limits of the claim. The outermost portions are worked out first, and as the excavation is carried back to the shaft, the roof and overlying muck are allowed to cave in and settle down on to the bed-rock. Timbering is thus entirely avoided. This absence of timbering in the Klondike shafts and tunnels is one of the most striking features in the mining; the frozen ground requires no support—it never thaws—and chambers as much as 100 feet square are covered by an icy roof which never breaks down.

The operations in the creeks are carried on upon a very considerable scale, and there is a large amount of machinery in the country; upon some groups of claims the work is not carried on by sinking and drifting, but is more of the nature of open quarrying. Night work is prosecuted by electric light or the acetylene lamp.

Formerly the raising of the gravel and its storage in dumps were mainly carried on in the winter, and the sluicing in the summer, and enormous winter dumps were accumulated for summer work. This last year the greater part of both has been carried on simultaneously during the summer, and it seems likely that the winter work will become less usual, and may even be abandoned altogether.

The mining upon the hillside claims bears no resemblance in appearance to ordinary placer mining. Horizontal tunnels are driven into the White Channel from the face of the hill, and shafts are sunk into it from the surface in a manner that more nearly resembles the working in ordinary metalliferous lodes. In one such mine which I visited, a horizontal tunnel 700 feet in length had been driven into the gravel, and at right angles to this, and at intervals of about 60 feet, lateral tunnels were being driven to a distance of 70 feet on either side; and there were 200 feet of pay gravel above the tunnel; the men were working with pick and shovel at the end of the long tunnels, and cars of rock were being wheeled along a tramway to the head of the long wooden shoot which carried the gravel down to the creek.

In these high-bench claims, as they are called, two great difficulties are encountered: (1) the difficulty of disposing of the tailings, which cannot be allowed to slide down upon the creek claims but must be artificially banked up; and (2) the difficulty of obtaining water at this height. Both have cooperated to prevent hydraulicking, which would otherwise be the obvious way of working gravels situated upon a steep hillside.

On Hunker Creek, however, Mr. Johanson, who owns both creek and hillside claims, has, with much enterprise and at very great expense, introduced hydraulicking upon a considerable scale. The

water was here derived from a reservoir in the creek, and was raised by a 140 horse-power engine to a height of 260 feet, the level of the hillside workings, and then to an additional height of 40 feet to an elevated tank, which gives a total fall of about 60 feet available for hydraulicking. The water was conducted through a 10-inch pipe and 6-inch hose terminating in a 2½-inch nozzle. About 1,200 Canadian gallons a minute could be delivered. This enabled one man to wash out no less than 8 cubic yards per hour, and the gravel was washed straight into the sluice-boxes without the necessity for intermediate labor.

If ever water becomes more abundant and accessible in the district, there can be no doubt that hydraulicking will be largely employed.

On Bonanza Creek I witnessed another novelty in the first operations of a new dredging plant which had just been introduced, having been formerly employed on an auriferous sand bar upon the Lewes River. It is very possible that dredging will prove to be an efficient and economical way of working over some of the old claims in the creeks which have only been treated by the cruder methods of the earlier miners.

There are other introductions which were new at the time of my visit; although no crushing of quartz had then been effected, a small Tremaine mill had just been erected on the banks of the Klondike in the immediate neighborhood of Dawson, and it is to be hoped that we shall soon hear of promising results among the quartz discoveries. An auriferous conglomerate found in considerable deposits on the Indian River was attracting much attention, chiefly on account of its superficial resemblance to the South African banket.

In default of resources other than gold, the prosperity of Klondike in the immediate future appears to me to depend mainly upon the extent to which in the creeks water can be more economically and bountifully supplied, labor and the necessaries of life more cheaply obtained, and communication be made more easy, so that it may be possible to work low-grade gravel at a profit. There is much auriferous material which it does not at present pay to touch. The Government is giving every encouragement, and in Mr. Ross the Territory has a strong governor; roads have been constructed; the royalty has been reduced to 5 per cent., and on all claims $5,000 of gold are exempt. The necessary charges are only $10 for a miner's license, $15 for recording a claim, $50 for surveying, $15 for renewal, and an owner is only required to put $500 worth of work on to his claim each year.

But the cost of water, wood, labor and materials is almost prohibitive; the standard of living is high, although there is, I think, a

constantly increasing number of steady and thrifty men coming into the country and replacing the more gambling element of the early camp.

The ultimate prosperity of the country depends largely, I think, upon the extent to which auriferous quartz may be discovered, and other resources developed.

But it is certain that Dawson has come with the intention of staying, and that the country is very far from played out. Not only is there a considerable quantity of ground yet to be worked in the Klondike creeks, but it must be remembered that much of the vast Yukon territory is auriferous, and that attention has only been distracted from other localities by the extraordinary wealth of the Klondike area.

Now that the district possesses a large town, inhabited throughout the year, now that communication is being facilitated, that freight rates are being lowered, and that the population is increasing, it ought to be possible to open up districts that could never have been attempted under the more adverse conditions of two or three years ago.

Coal is being mined at Cliff Creek, 55 miles below Dawson, and at Five Fingers, about 200 miles above Dawson; placer copper exists in large quantities on the White River; copper ores have been found near White Horse; the Atlin district promises well; horses, cattle, and sheep will shortly be supported in the country itself, and vegetables and other produce will be raised.

It only remains to be seen whether the cost of production can be so far diminished that this far northwestern Territory will be able to compete with other regions which are more favorably situated.

That the inhabitants have the necessary enterprise and energy I know from what I have seen of them. It is, in fact, most interesting to note how in this isolated country native grit and intelligence have brought the best men to the front. One naturally associates the element of luck with placer mining, and no doubt many fortunes were made and lost by sudden strokes of chance. But in no mining district have previous experience and knowledge been of less avail. The conditions were so strange, that the old and experienced miners sometimes made the worst mistakes, and the men who succeeded were those who were sufficiently alert and intelligent to adapt themselves to the new conditions. One finds among the leading miners—men who have come from all places and from all classes of society—men who two or three years ago were workmen, hotel clerks, store assistants, or farmers.

I cannot conclude without a word of tribute to the magnificent work which has been done by the Canadian Northwest Mounted Police, and the excellent way in which the inhabitants have settled

down under their rule. A mere handful of this fine military force have sufficed to introduce law and order into the country, from the time of the great rush in 1897. The perfect quiet which prevails, and has always prevailed, on the Canadian side of the frontier contrasts most favorably with the lawless scenes that took place till recently at Skagway and other places in American territory. Even the disorderly population which migrated into Klondike seemed to lose its character on Canadian territory, and the six-shooter was no more seen.

I doubt whether any better example exists of the manner in which, in any part of the world, the finest features of British character will prevail—the firmness, good temper, and love of order which are the dominant characteristics of our most successful colonists.

A STUDY OF TWENTIETH CENTURY SUCCESS.

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SOMEONE has said, with more or less philosophical insight, that all questions resolve themselves into three classes: those of the 'What,' the 'How,' and the 'Why.' In this paper it is primarily a question of the 'How' that is considered. How have the men and women, who in the opening year of this twentieth century are prominently in the public eye, achieved the success in their various vocations which has placed them there? What have been the stepping-stones to that success? How can we follow in their footsteps? The biographies of great men have done much to answer this question, still they leave much unsaid. The tow-path and the flat-boat do not furnish nowadays the shortest route to the eminence upon which the ambitious youth has fixed his eye, and he wants more guide posts by the way.

In an attempt to discover the general route to that goal, I have studied a few facts from the lives of many, rather than many facts from the lives of a few. The basis of the study is 'Who's Who in America' for 1900. This book, of which the edition of 1900 was the first, is for America what the English volume of the same name has been for England for more than half a century, namely, an address book of living celebrities—if we give this term considerable extension—containing a brief biographical sketch of each. This includes in most cases date of birth, particulars as to schooling, present profession and address, together with any unusual accomplishment or public service. The edition of 1900 contains 8,602 names and in my study of them the first three biographical facts mentioned were considered. I shall say nothing in defense of the criterion of success which I am here taking: that is, mention in 'Who's Who.' On what constitutes real success in life probably no two of us could agree. It would, however, be acceded by all who are familiar with the book, that although it fails to mention many who are as worthy a place in its pages as are some who appear there, it is nevertheless true that each whom it has mentioned has attained a degree of eminence which warrants the assertion that, at least before the public, success has crowned his efforts to a degree not achieved by the ordinary run of mankind.

Whatever success may mean, it would be safe to say that it depends upon two things: nature and nurture. On the nature side of the

problem, we find no help in 'Who's Who' since ancestry is not included. On the nurture side, which would mean education in its broadest sense, we find facts descriptive of certain phases only, namely those of the schools. How important a place they take in the education of the individual can never be determined with any degree of exactness, but even with a full recognition of the force of the home, the church, the state and the vocation, it must be conceded that their influence as an organized educational machine is very great. Facts bearing upon this influence are the ones principally furnished by 'Who's Who' and, together with those of age, the only ones considered here.

FIG. 1.

A mention of 8,602 names in the volume in question means, if we assume that every inhabitant of the United States above the age of twenty-one was eligible to such mention, that one in each six hundred was so honored. This then, would be our ratio of success for all degrees of education—good, bad and indifferent. We find, however, that of the whole number mentioned, 3,237 had received the bachelor's degree in arts, literature, science or philosophy at some college or university. But a study of the alumni lists of such institutions shows us that after the commencement season of 1899 there were 334,000 living graduates. A comparison of the number mentioned in the book (3,237) with this whole number alive shows us that one college graduate in each one hundred and six found a place. Here then we have the ratio of success for college graduates. But to carry our process of comparison one step farther: taking 1:600 as the ratio of success (the 'Who's Who' kind) for the adult American, and 1:106 as that for the college graduate, we find that the probability of success is increased more than 5.6 times by a college education. This relation is shown graphically in Fig. 1. This tremendous advantage can probably not be attributed entirely to the direct educational effect of such a training, but, to a considerable extent, to the selective influence of the course. Of the whole number of pupils who

enter the elementary schools, but a very small percentage continues to the completion of the college course. This comparatively small number of persisters does not fairly represent what our educational machinery could have done with the entire number who started at the bottom, but what that machinery can do with the kind nature had endowed with sufficient energy, determination and persistence to enable them to withstand the temptations to drop out one by one by the way and take a seemingly short cut to some *ignus fatuus* of success, but who continue to the end. There is here shown undoubtedly with considerable force the potency of the law of the survival of the fittest, if we take as our criterion of fitness mention in 'Who's Who.' This, however, does not invalidate the fact that the college course, either because of its educational or selective influence, increases largely, perhaps to the extent we have shown, the probability that the graduate will gain a favorable place in the public eye.

A classification of the names in the book which forms the basis of our study, in terms of the various professions and vocations, gives us the following numbers for the twenty-four which seem to form the most natural divisions. *Actor:* male 54, female 40. *Artist,* including illustrators: male 260, female 21. *Author,* including writer, historian, novelist and poet: male 528, female 272. *Business,* including the various mercantile pursuits: male 200. *Clergyman,* including bishop, rabbi, missionary, priest, salvation army and monk: male 655, female 7. *College professor,* including president, dean and chancellor: male 1,090, female 11. *Congressman* (both senate and house): 446. *Editor,* including journalist, critic, correspondent and reporter: male 509, female 13. *Educator,* including superintendent, teacher, philanthropist and reformer: male 188, female 30. *Engineer,* including architect and miner: male 284. *Financier,* including capitalist and banker: male 215. *Inventor:* male 26. *Lawyer,* including justice, judge and jurist: male 857, female 4. *Lecturer:* male 21, female 6. *Librarian:* male 362, female 9. *Musician,* including singer: male 111, female 21. *Physician:* male 540, female 7. *Railroad official:* male 102. *Sailor:* 103. *Scientist,* including naturalist: male 416, female 7. *Soldier:* 205. *Statesman,* including governor, diplomat, politician and mayor: 202. *U. S. official:* male, 98, female 1. *Miscellaneous,* running all the way from farmer to insurance president: male 53, female 2. The sum of these figures does not quite equal 8,602, the number which, as has already been stated, the book mentions, since a comparatively small number who failed to give the year of birth were not included in the study.

One question, among others, which the young person about to choose a profession is apt to consider is this: How long will it take to get a foothold? How many years of hard sledding before the

smooth road is reached? Both ambition and pocket are interested in the answer and without doubt many a young man has been influenced in his choice of profession by his conclusion on this matter. The data at my command throw light only indirectly on this question, but more directly on another. How long must I wait for eminence, if it ever comes, and in what profession may I expect it earliest? If there be any fixed relation between a foothold and success, then the former question may be answered by inference. A tabulation of the ages of each of the eight thousand and more individuals of both sexes for the vocations mentioned above (with the exception of a few less frequently chosen) is shown graphically in Figs. 2 and 3. The former is for males and the latter for females, though the gentler sex was a competitor of sufficient strength to warrant consideration in seven only. In each of the figures the vocations are indicated at the bottom. Of the two heavy vertical lines (ordinates) above each vocation, the one at the left indicates by its height the percentage of the whole number

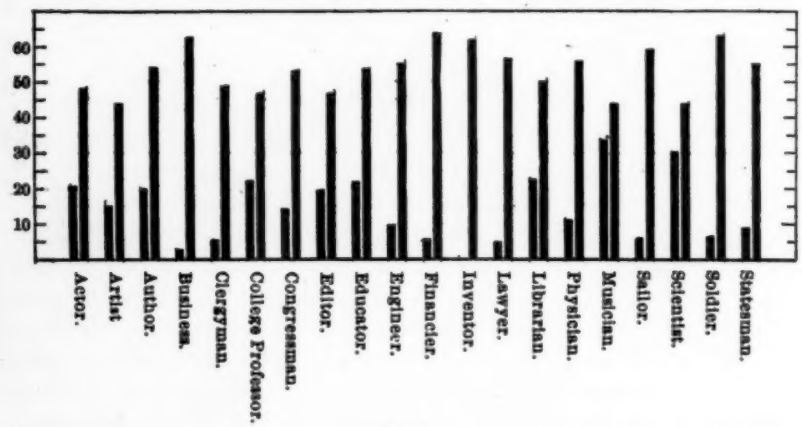

FIG. 2.

mentioned who were below forty years of age; in other words, the percentage of young men and women who had achieved eminence in it, if we may assume that a person is young until he is forty. The ordinate at the right of each pair shows in a similar manner by its height the average age in years of all those mentioned for the vocation indicated below. In each case the ordinates are to be read by means of the scales at the left and right of the figure: the *youth* ordinate in percentages and that for *age* in years, although the figure is so drawn that the same scales apply to both. These figures show then, as fully as an inductive study based upon a limited number of data will permit, (1) the relative probability of achieving early distinction in the various professions, (2) the average ages of persons of distinction in those professions, (3) a basis of comparison for the two sexes.

An inspection of Fig. 2 from the standpoint of the first of these possibilities (noting only the *left* of each pair of ordinates) shows at a glance that the musician distances all competitors in the race for distinction. This is not hard to understand when we recall the infant prodigies who frequently figure on our bill boards, or consider that nature has in most cases contributed more largely to his success than has nurture. Of those callings which presuppose a professional or at least an extended preparation, that of scientist seems from our figure to promise the earliest recognition. This is perhaps due to the fact that for him the actual work of life is entered with a completer intellectual equipment than by most of the others, and that the period of preparation offers opportunities for research and original investigation which may bring renown even before life work is begun. This would also apply to the college professor with perhaps fully as much force and in a lesser degree to the librarian and the educator. These four then might be included in a class in which the period of preparation is extended, but for which work of a high order might be expected immediately on its completion and positions of some prominence aspired to from the start. Next in the race for renown come the actor and the author, almost neck and neck. If we concluded that nature had most to do with the musician's success and nurture with the educator's we should be forced to place the author and the actor in a class in which those two forces divide the honors more evenly. No doubt one must be born an actor or an author to rise to a high rank, but after all, the making process is not to be despised as a factor, and this takes time. Except for the soldier and the sailor, whose ability to rise to prominence, at least in time of peace, is determined by the rapidity with which those above him are retired from service, and the congressman and the statesman, whose minimum limit is prescribed by law, the rest of the vocations shown upon the chart fall, it seems to me, into a class for which the schools, as organized means of education, provide no adequate preparation and for which that preparation must come, to a great extent, from the vocation itself. As an illustration of what I mean: the scientist, or even the college professor, who has devoted thirty years of life to study, can enter the profession from the top, while the business man and financier, for whom the accumulation of wealth is a desideratum, or the lawyer and the doctor, who must command a practice, or the minister, who needs a congregation, must, with the same period of intellectual infancy, enter it from the bottom and devote a few more years to the climbing process. In so far as the physician is an investigator the conditions of the scientist apply to him and no doubt the considerable number who are such accounts for the fact that his recognition comes earlier than that of his competitors in law and the pulpit. The surprising thing of the figure is perhaps the slowness with

which the inventor gains a foothold on the ladder to fame. Not one of those mentioned was below the age of forty, though not enough names were included to give this fact great weight.

A study of Fig. 2 from the standpoint of average ages of those mentioned (note only the *right* ordinate of each pair) discloses little which would not have been expected from the facts already stated. It will be seen that where recognition was early, the average age is comparatively small, while for those vocations in which the climb was a tedious one, the age is much greater. Certainly one whose ambition was early renown would not, from the showing of our figures, choose business or finance. Since, however, these professions are seldom entered for glory, we need not fear a lack of aspirants for the rewards which they bring. When nature has done most for the man as in the case of the actor, author and musician the laurel crown comes earliest. If one must depend upon nurture as most of us must, the scientist, the college professor, the editor, the educator and the clergyman may hope to wear it longest and in the order given.

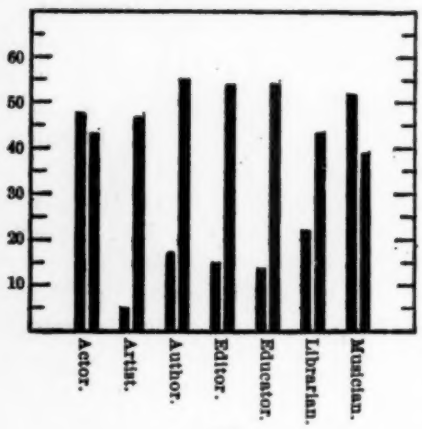

FIG. 3.

As has been stated, Fig. 3 shows for women the conditions which have just been discussed for men, for those callings in which they have been to any extent competitors. It shows that upon the stage and in musical circles recognition is much earlier for them, while in the other callings it is slower than for their brothers. In other words, nature works quicker with her and nurture slower, if our figures are to be accepted. It is perhaps worthy of mention too, that the two professions in which she outstrips him are the only ones in which attractiveness of person would be at a premium; perhaps at so much of a premium as to make up for some other defects. When, however, this is outlived with youth the struggle seems to be a hard if not a losing one.

We have now to consider the educational preparation of the persons whose names are included under the several vocations. This so far as it has to do with the schools—the only data at our disposal—is shown by the somewhat complicated-looking Figs. 4 and 5, the former for the men and the latter for the women. Upon each of them the vocations are indicated at the bottom as in those just explained. Of the variously constructed ordinates above each name, that part which is wholly black

shows by its height the percentage of those named for that vocation who mentioned no schooling above the elementary or secondary grade. This would probably mean in most cases that the educational preparation was carried no farther. That portion of the ordinate which has heavy black lines at the sides shows in the same manner the percentage of those mentioned who had received the baccalaureate degree at some college or university; that portion having a heavy line in the center, the percentage who had completed a professional course; that portion which has the heavy lines both at the side and in the middle, the percentage who had pursued both the college and professional course; the portion between the top of the ordinate and the horizontal line at the top of the figure, the percentage educated entirely abroad, and the little line extending out from some of the ordinates, by its distance from the base line, the percentage who had taken some postgraduate degree. Honorary degrees are not included. In every case, the per-

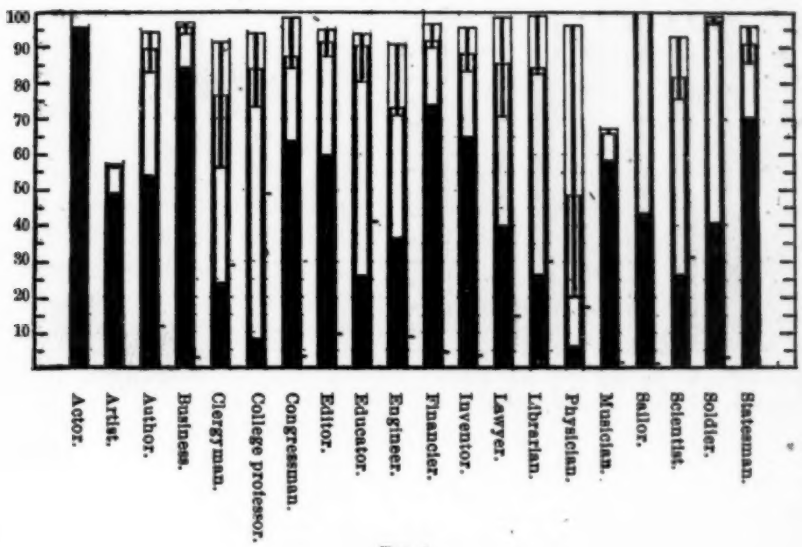

FIG. 4.

centages are to be read by means of the scale at the right and left of the figure. As an illustration of the interpretation of one of the ordinates I will take that for clergymen: 24 per cent. are shown to have no education above the high school (black portion), 52 per cent. have a college education (heavy side lines 76—24=52), 35 per cent. have a professional education, presumably, the divinity school (heavy middle line 91—56=35), 20 per cent. have both (heavy side and middle lines 76—56=20), 9 per cent. were educated entirely abroad and were presumably largely foreigners (distance between top of ordinate and top of figure, 100—91=9), 28 per cent. had taken a postgraduate degree

(distance between base line and small mark at right of ordinate). The ordinates for each of the other professions may be interpreted in the same manner. The data in my possession make possible the study of various other combinations of educational courses, as well as comparisons of them for persons of different ages showing the educational trend, but lack of space prevents a discussion of these facts in the present paper. I will say, however, that the figures do not show combinations of training abroad with that in our home institutions. The spaces on the figures which have to do with training abroad refer only to those persons who failed to make any use whatever of home institutions, at least above high school.

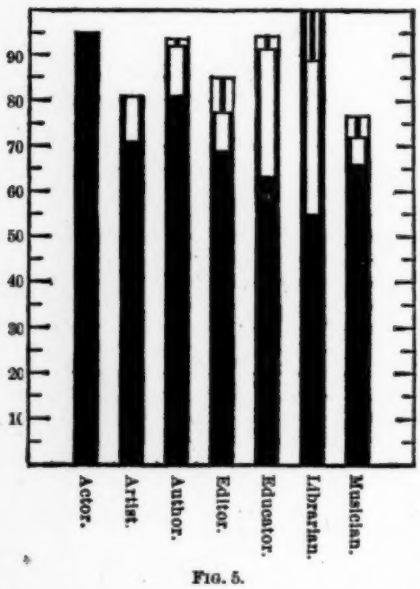

FIG. 5.

Figures 4 and 5 then show (1) the educational preparation of persons of both sexes for the various professions and (2) a basis of comparison between the two. They answer, too, a very important question: "What kind of preparation has proved most essential to that kind of success which mention in 'Who's Who' means?" They have nothing to do with the question, 'What kind of preparation must the doctor, or the lawyer, or the minister have to be a doctor, or a lawyer, or a minister,' but what kind is most likely to put him in the class of doctors, and lawyers, and ministers who achieve eminence. In other words, we are studying selected persons in each profession, but since every man and woman of proper ambition who enters a profession hopes to be one of those selected, the problem has a wide bearing.

In the discussion of the figures which follows I shall, for the sake of directness and with full recognition of the fact that the two are not synonymous, speak of those under each profession whose education stopped with the high school (black portion of the ordinates) as *uneducated*. Of this class the actor shows by far the greatest number —so large that we could hardly advise the young person with histrionic ambition to go to college merely as an aid to public recognition in his art. There may be other inducements for him, but seemingly not that.

Business seems to offer the next largest inducement to the uneducated; 84 per cent. of its devotees belong to that class. Twelve per

cent. had, however, completed the college course, and this in my opinion is enough to invalidate the arguments of C. P. Huntington and others against such training for business men. We have no means of knowing just how many of our business men throughout the country have taken the college course, but computed roughly, one man in about 300 of all grades and stations in life has been so educated. Since this includes mill operatives and other classes in which such training is practically unknown, we must assume that the ratio would be much larger for the business man. Yet it seems to me that even a most generous estimate could not bring it up to one in eight—that of our business men of eminence—and we should be forced to conclude that the college course has even for him, remote as the connection seems to be, been a contributor to his success. This argument would also apply to the financier, who comes next with his 18 per cent. of college graduates. Our statesmen, the next class, and the congressmen, who differ but little, are hardly to be congratulated on their showing. Thus one may say that with our whole male citizenship eligible to those positions of honor—the boast of our republic—whose ratio of college training is one to 300, while that for the eminent man of these two classes is about one to five as shown by our figure, the probability of gaining such honorable mention is increased about sixty-fold for these our law-makers and diplomats by the college course, an increase which is not to be despised by those who aim at these high places at popular disposal. This too for college conditions in which departments of finance and special facilities for diplomatic training have not played so important a part as they are likely to in the future. Although artists and musicians seem to be uneducated classes we must not neglect the fact shown by the figure that large numbers (43 per cent. and 33 per cent. respectively) were educated abroad, where undoubtedly they were spending their time to better advantage than could have been done in any college at home. Next after the sailor and the soldier, whose heavy black lines upon the figure bear testimony to the efficiency of our national academies for the training of officers on land and sea, comes, in our descending scale of learnedness, the lawyer. His educational showing, when compared with that of the sister professions of medicine and theology, is not a favorable one. With 40 per cent. of the shining lights of our legal fraternity innocent either of professional training or of academic instruction beyond the high school, we wonder what the education of the lesser lights may be and whether really much education is essential to success. The records of the bar examination in the various states are so kept, or rather so not kept, as to make it impossible to ascertain the previous training of those admitted, so I am unable to show these facts for the rank and file of the profession. The reports of the U. S. Commissioner of Education, however, show that for the last twenty years 27 per cent.

of the students registered in the law schools of our country had already taken the bachelor's degree in some academic institution. This may then be taken as the percentage of lawyers throughout the country who have had the liberal training of the college course. But of our eminent lawyers the percentage so trained is forty-six, implying that the college educated lawyer's chances of being counted among the immortals of 'Who's Who' are nearly doubled. This relationship is more exactly shown in Fig. 6. Without discussing the engineer, the librarian, the scientist or the educator, whose educational conditions are shown and for whom no further comparisons can be made, the clergyman comes in for his share in the analysis. In his case we find about one fourth are uneducated, one half with college education and one third, that of

FIG. 6.

the professional school. For him too we have only the figures of the U. S. Commissioner as a basis of comparison. Of the divinity school students of our land we there find that 24.7 per cent. have taken a college degree. But of the 'Who's Who' clergy, 53.3 per cent. had been so rewarded. The premium which a comparison of these two puts upon the college bred minister is also shown in Fig. 6 and is one not to be disregarded by the aspirant for pulpit honor. On the score of post-graduate attainments the clergyman is shown to be an industrious worker.

The banner professions, so far as educational accomplishments are concerned, are seen to be those of college instruction and medicine, with the showing slightly in favor of the latter if we disregard post-graduate honor, in which the college men easily outrank all others. These, too, have made more extensive use of opportunities for study

abroad in connection with the home training, though this fact is not shown in the figure, nor is another fact of interest, namely, that they have made the most rapid improvements in their intellectual equipment as shown by a study by decades for the last sixty years. We have, however, no data upon which to base a comparison of the 'rank' with the 'file.'

For the physicians we can only rely once more upon the Commissioner of Education. He states that 7.5 per cent. of the medical students of the country have taken the academic degree. Yet we find—*mirabilé dictu*—that 42 per cent. of the 'Who's Who' physicians have been recipients of that degree. Nearly six times as many of the 'rank' as of the 'file' (see Fig. 6). It seems hardly probable that the college training can be at such a premium in the actual practice of the medical man, so it seems to me we must conclude that it is as a scientist and a producer that such a training counts for most. The scientific societies of the physician undoubtedly stimulate more of their members to original research and investigation, and consequently to a greater productiveness, than do similar organizations among clergymen and lawyers, and it is here that the broader training would count for most. We must, in any event, from the facts disclosed by our study, conclude that of the three generally recognized learned professions, the medical leads in the breadth and perfection of its educational preparation.

A study of the education of women, based upon Fig. 5, is disappointing, and from it we are forced to one of two conclusions: either (1) that women can attain an eminence equal to that of men, with less dependence upon educational machinery, or (2) that the compilers of the book upon which our study is based have made use of a different and lower criterion in judging them. In the case of no one of the vocations shown upon the figure was her training so complete as was that of her male competitor for honors, and the same was true for the limited number of doctors, lawyers and ministers mentioned for the sex. In no one of the vocations, except that of the stage, was the difference so slight as to leave any doubt on the question. The most discouraging thing about it too, as disclosed by a study by decades but not shown upon any of the figures, is that for recent years, when institutions of nearly all classes have been as freely open to woman as to man, there seems to be no change for the better. Her educational inertia, due very naturally to centuries lacking in opportunity, is not easily thrown off, and, until it is—a time which seems not yet to have arrived—she can not take her place with man in the professional world, even should she consider it as properly her sphere.

THE PANAMA ROUTE FOR A SHIP CANAL.*

By Professor WILLIAM H. BURR,
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THE Panama route as a line of transit across the isthmus was established, as near as can be determined, between 1517 and 1520. The first settlement, at the site of the town of old Panama, six or seven miles easterly of the present city of that name, was begun in August, 1517. This was the Pacific end of the line. The Atlantic end was finally established in 1519 at Nombre de Dios, the more easterly port of Acla, where Balboa was tried and executed, having first been selected but subsequently rejected.

The old town of Panama was made a city by royal decree from the throne of Spain in September, 1521. At the same time it was given a coat of arms and special privileges were conferred upon it. The course of travel then established ran by a road well known at the present time through a small place called Cruces on the River Chagres, about seventeen miles distant from Panama. It must have been an excellent road for those days. Bridges were even laid across streams and the surface was paved, although probably rather crudely. According to some accounts it was only wide enough for use by beasts of burden, but some have stated that it was wide enough to enable two carts to pass each other.

The harbor of the Atlantic terminus at Nombre de Dios did not prove entirely satisfactory and Porto Bello, westerly of the former point, was made the Atlantic port in 1597 for this Isthmian line of transit. The harbor of Porto Bello is excellent and the location was more healthful, yet Porto Bello itself was subsequently abandoned, largely on account of its unhealthiness.

As early as 1534 or soon after that date boats began to pass up and down the Chagres river between Cruces and its mouth on the Caribbean shore, and thence along the coast to Nombre de Dios and subsequently to Porto Bello. The importance of the commerce, which sprang up across the isthmus and in connection with this Isthmian route, is well set forth in the last paragraph on page 28 of the report of the Isthmian Canal Commission:

> The commerce of the isthmus increased during the century and Panama became a place of great mercantile importance, with a profitable trade extending to the Spice Islands and the Asiatic coast. It was at the height of its

* The substance of this paper has been delivered as a lecture by the author and will soon be published in a series of lectures on civil engineering.

prosperity in 1585, and was called with good reason the toll-gate between western Europe and eastern Asia. Meanwhile the commerce, whose tolls only brought such benefits to Panama, enriched Spain, and her people were generously rewarded for the aid given by Ferdinand and Isabella in the effort to open a direct route westward to Cathay, notwithstanding the disadvantages of the isthmian transit.

This commercial prosperity suggested to those interested in it, and soon after its beginning, the possibility of a ship canal to connect the waters of the two oceans. It is stated even that Charles V. directed that survey should be made for the purpose of determining the feasibility of such a work as early as 1520.

The governor, Pascual Andagoya, reported that such a work was impracticable and that no king, however powerful he might be, was capable of forming a junction of the two seas or of furnishing the means of carrying out such an undertaking.

From that time on the city of Panama increased in wealth and population in consequence of its commercial importance. Trade was established with the west coast of South America and with the ports on the Pacific coast of Central America. In spite of the fact that it was made by the Spaniards a fortress second in strength in America only to old Cartagena it was sacked and burned by Morgan's buccaneers in February, 1671. The new city, that is the present city, was founded in 1673, it not being considered advisable to rebuild on the old site.

The project of a canal on this route was kept alive for more than three centuries by agitation, sometimes active, and sometimes apparently dying out for long periods until there was organized in Paris in 1876 a company entitled 'Société Civile Internationale du Canal Interocéanique,' with Gen. Etienne Turr as president, for the purpose of making surveys and explorations for a ship canal between the two oceans on this route.

The work on the isthmus for this company was prosecuted under the direction of Lieut. L. N. B. Wyse, a French Naval Officer, and he obtained for his company in 1878 a concession from the Columbian Government conferring the requisite rights and privileges for the construction of a ship canal on the Panama route and the authority to do such other things as might be necessary or advisable in connection with that project. This concession is ordinarily known as the Wyse concession.

A general plan for this transisthmian canal was the subject of consideration at an international scientific congress convened in Paris in May, 1879, and composed of 135 delegates from France, Germany, Great Britain, the United States and other countries with a majority from France. This Congress was convened under the auspices of Ferdinand de Lesseps, and after remaining in session for two weeks a decision, not unanimous, was reached that an interoceanic canal

ought to be located on the Panama route, and that it should be a sea level canal without locks. The fact was apparently overlooked that the range between high and low tides in the Bay of Panama, about twenty feet, was so great as probably to require a tidal lock at that terminus.

A company entitled 'Compagnie Universelle du Canal Interocéanique' was organized with Ferdinand de Lesseps as president, immediately after the adjournment of the international congress. The purpose of this company was the construction and operation of the canal, and it purchased the Wyse concession from the original company for the sum of 10,000,000 francs. An immediate but unsuccessful attempt was made to finance the company in August, 1879. This necessitated a second attempt, which was made in December, 1880, with success, as the entire issue of 600,000 shares of 500 francs each was sold. Two years were then devoted to examinations and surveys and preliminary work upon the canal, but it was 1883 before operations upon a large scale were begun. The plan adopted and followed by this company was that of a sea level canal affording a depth of 29.5 feet and a bottom width of 72 feet. It was estimated that the necessary excavation would amount to 157,000,000 cu. yds.

The Atlantic terminus of the canal route was located at Colon and at Panama on the Pacific side. The line passed through the low ground just north of Monkey Hill to Gatun, six miles from the Atlantic terminus, and where it first met the Chagres River. For a distance of twenty-one miles it followed the general course of the Chagres to Obispo, but left it at the latter point and passing up the valley of a small tributary cut through the continental divide at Culebra and descended thence by the valley of the Rio Grande to the mouth of that river where it enters Panama Bay. The total length of this line from 30 ft. depth in the Atlantic to the same depth in the Pacific was about 47 miles. The maximum height of the continental divide on the center line of the canal in the Culebra cut was about 333 ft. above the sea, which is a little higher than the lowest point of the divide in that vicinity. Important considerations in connection with the adjacent alignment made it advisable to cut the divide at a point not its lowest.

Various schemes were proposed for the purpose of controlling the floods of the Chagres River, the suddenness and magnitude of which were at once recognized as among the greatest difficulties to be encountered in the construction of the work. Although it was seriously proposed at one time to control this difficulty by building a dam across the Chagres at Gamboa that plan was never adopted, and the problem of control of the Chagres floods remained unsolved for a long period.

It was estimated by de Lesseps in 1880 that eight years would be required for the completion of the canal, and that its cost would be $127,600,000. The company prosecuted its work with activity until

the latter part of 1887 when it became evident that the sea level plan of canal was not feasible with the resources at command. Changes were soon made in the plans, and it was concluded to expedite the completion of the canal by the introduction of locks, deferring the change to a sea-level canal until some period when conditions would be sufficiently favorable to enable the company to attain that end. Work was prosecuted under this modified plan until 1889, when the company became bankrupt and was dissolved by judgment of the French Court, called the Tribunal Civil de la Seine, on February 4, 1889. An officer called the liquidator, corresponding quite closely to a receiver in this country, was appointed by the court to take charge of the company's affairs. At no time was the project of completing the canal abandoned, but the liquidator gradually curtailed operations and finally suspended the work on May 15, 1889.

He determined to take into careful consideration the feasibility of the project, and to that end appointed a 'commission d'études,' composed of eleven French and foreign engineers, headed by Inspector-General Guillemain, director of the École Nationale des Ponts et Chaussées. This commission visited the isthmus and made a careful study of the entire enterprise, and subsequently submitted a plan for the canal involving locks. The cost of completing the entire work was estimated to be $112,500,000, but the sum of $62,100,000 more was added to cover administration and financing, making a total of $174,600,000. This commission also gave an approximate estimate of the value of the work done and of the plant at $87,300,000, to which some have attached much more importance than did the commission itself. The latter appears simply to have made the 'estimate' one half of the total cost of completing the work added to that of financing and administration, as a loose appproximation, calling it an 'intuitive estimate'; in other words, it was simply a guess, based upon such information as had been gained in connection with the work done on the isthmus.

By this time, the period specified for completion under the original Wyse Concession had nearly expired. The liquidator then sought from the Colombian Government an extension of ten years, which was granted under the Colombian law dated December 26, 1890. This extension was based upon the provision that a new company should be formed and work on the canal resumed not later than February 28, 1893. The latter condition was not fulfilled, and a second extension was obtained on April 4, 1893, which provided that the ten-year extension of time granted in 1890 might begin to run at any time prior to October 31, 1894, but not later than that date. When it became apparent that the provisions of this last extension would not be carried out an agreement between the Colombian Government and the new Panama Company was entered into on April 26, 1900, which extended

the time of completion to October 31, 1910. The validity of this last extension of time has been questioned.

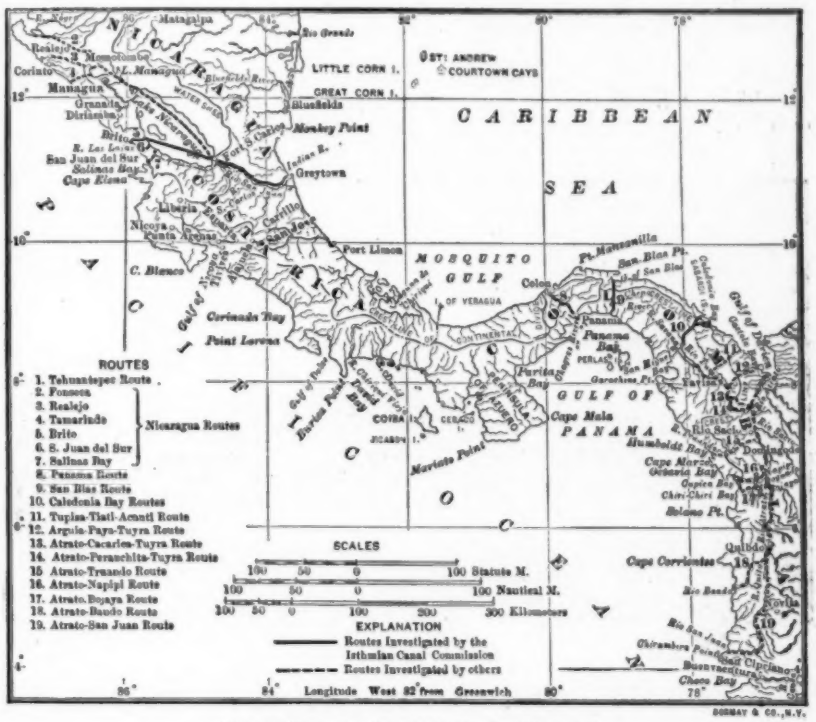
A new company, commonly known as the new Panama Canal Company, was organized on October 20, 1894, with a capital stock of 650,000 shares of 100 francs each. Under the provisions of the agreement of December 26, 1890, authorizing an extension of time for the construction of the canal, 50,000 shares passed as full paid stock to the Colombian Government, leaving the actual working capital of the new Panama Company at 60,000,000 francs, that amount having been subscribed in cash. The most of this capital stock was subscribed for by certain loan associations, administrators, contractors and others against whom suits had been brought in consequence of the financial difficulties of the old company, it having been charged, in the scandals attending bankruptcy proceedings, that they had profited illegally. Those suits were discontinued under agreements to subscribe by the parties interested to the capital stock of the new company. The sums thus obtained constituted more than two thirds of the 60,000,000 francs remaining of the share capital of the new company after the Colombian Government received its 50,000 shares. The old company had raised by the sale of stock and bonds not far from $246,000,000, and the number of persons holding the securities thus sold has been estimated at over 200,000.

The Panama Railroad Company holds a concession from the Colombian Government, giving it rights prior to those of the Wyse Concession, so that the latter could not become effective without the concurrence of the Panama Railroad Company. This is shown by the language of Article III. of the Wyse Concession, which reads as follows:

> If the line of the canal to be constructed from sea to sea should pass to the west and to the north of the imaginary straight line which joins Cape Tiburon with Garachine Point the grantees must enter into some amicable arrangement with the Panama Railroad Company or pay an indemnity, which shall be established in accordance with the provisions of law 46 of August 16, 1867, 'approving the contract celebration on July 5, 1867, reformatory of the contract of April 15, 1850, for the construction of an iron railroad from one ocean to the other through the Isthmus of Panama.'

It became necessary therefore in order to control this feature of the situation for the old Panama Company to secure at least a majority of the stock of the Panama Railroad Company. As a matter of fact the old Panama Canal Company purchased nearly 69,000 out of the 70,000 shares of the Panama Railroad Company, each such share having a par value of $100. These shares of Panama railroad stock are now held in trust for the benefit of the new Panama Canal Company. A part of the expenditures of the old company therefore covered the cost of the Panama Railroad Company's shares, now held in trust for the benefit of the new company.

Immediately after its organization the new Panama Canal Company resumed the work of excavation in the Emperador and Culebra cuts with a force of men which has been reported as varying between 1,900 and 3,600. It also gave thorough consideration to the subject of the best plan for the completion of the canal. The company's charter provided for the appointment of a special engineering commission of five members by the company and the liquidator to report upon the work done and the conclusions to be drawn from its study. This report

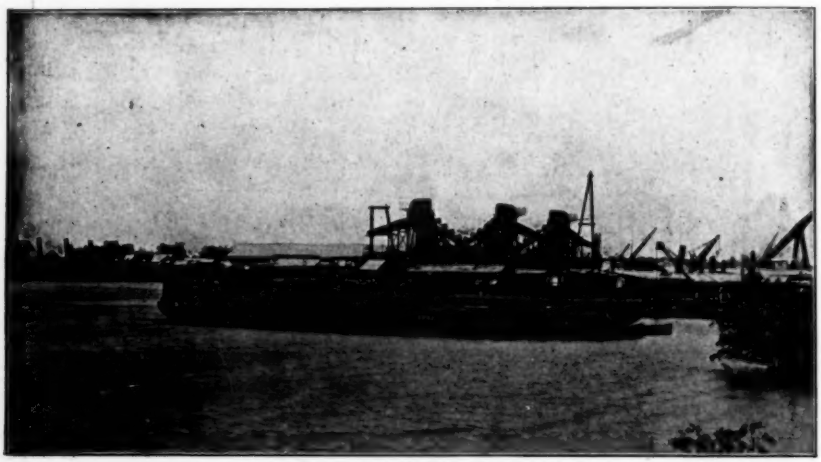


MAP OF CENTRAL AMERICA AND THE ISTHMUS.

was to be rendered when the amount expended by the new company should reach about one half of its capital. At the same time the company also appointed a 'Comité Technique,' constituted of fourteen eminent European and American engineers, to make a study of the entire project, which was to avail itself of existing data and the results of such other additional surveys and examinations as it might consider necessary. The report rendered by this committee was elaborate, and it was made November 16, 1898. It was referred to the statutory commission of five, to which reference has already been made, which commission reported in 1899 that the canal could be constructed within the limits of time and money estimated. On December 30, 1899, a

special meeting of the stockholders of the new company was called, but the liquidator, who was one of the largest stockholders, declined to take part in it, and the report consequently has not received the required statutory consideration.

The plan adopted by the company placed the minimum elevation of the summit level of the canal at 97.5 ft. above the sea and the maximum at 102.5 ft. above the same datum. It provided for a depth of 29.5 ft. of water and a bottom width of canal prism of about 98 ft., except at special places where this width was increased. A dam was to be placed near Bohio, which would thus form an artificial lake with its surface varying from 52.5 to 65.6 ft. above the sea. Under this plan there would be a flight of two locks at Bohio, about sixteen miles from the Atlantic end of the canal, and another flight of two locks at Obispo



OLD DREDGES NEAR COLON.

about fourteen miles from Bohio, thus reaching the summit level; a single lock at Paraiso, between six and seven miles from Obispo; a flight of two locks at Pedro Miguel, about 1.25 miles from Paraiso, and finally a single lock at Mira Flores, a mile and a quarter from Pedro Miguel, bringing the canal down to the ocean elevation. The location of this line was practically the same as that of the old company. The available length of each lock chamber was 738 ft., while the available width was 82 ft., the depth in the clear being 32 ft. 10 in. The lifts were to vary from 26 to 33 ft. It was estimated that the cost of finishing the canal on this plan would be $101,850,000, exclusive of administration and financing.

In order to control the floods of the Chagres River, and to furnish a supply of water for the summit level of the canal, a dam was planned to be built at a point called Alhajuela, about twelve miles from Obispo,

from which a feeder about ten miles long, partly an open canal and partly in tunnels or pipe, would conduct the water from the reservoir thus formed to the summit level.

Although the plan, as described, was adopted, the 'Comité Technique' apparently favored a modification by which a much deeper excavation through Culebra Hill would be made, thus omitting the locks at both Obispo and Paraiso, and making the level of the artificial lake Bohio the summit level of the canal. In this modified plan the bottom of the summit level would be about 32 feet above the sea, and the minimum elevation of the summit level 61.5 feet above the sea. This modification of plan had the material advantage of eliminating both the Obispo and Paraiso locks. The total estimated cost of completing the canal under this plan was about $105,500,000. Although the Alhajuela feeder would be omitted, the Alhajuela reservoir would be retained as an agent for controlling the Chagres floods and to form a reserve water supply. The difference in costs of these two plans was comparatively small, but the additional time required to complete that with the lower summit level was probably one of the main considerations in its rejection by the committee having it under consideration.

This brings the project up to the time when the Isthmian Canal Commission was created in 1899 and when the forces of the new Panama Canal Company were employed either in taking care of the enormous amount of plant bequeathed to it by the old company or in the great excavation at Emperador and Culebra. The total excavation of all classes, made up to the time when that commission rendered its report, amounted to about 77,000,000 cu. yds.

The work of the commission consisted of a comprehensive and detailed examination of the entire project and all its accessories, as contemplated by the new Panama Canal Company, and any modifications of its plans either as to alignment, elevations or subsidiary works, which it might determine advisable to recommend. In the execution of this work it was necessary among other things to send engineering parties on the line of the Panama route for the purpose of making such surveys and examinations as might be necessary to confirm estimates of the new Panama Canal Company as to quantities, elevations or other physical features of the line selected, or required in modifications of alignment or plans. In order to accomplish this portion of its work the commission placed five working parties on the Panama route with twenty engineers and other assistants and forty-one laborers.

The commission adopted for the purposes of its plans and estimates the route selected by the new Panama Canal Company, which is essentially that of the old company. Starting from the six-fathom contour in the harbor of Colon the line follows the low marshy ground adjoin-

ing the Bay of Limon to its intersection with the Mindi River; thence through the low ground continuing to Gatun, about six miles from Colon, where it first meets the Chagres River. From this point to Obispo the canal line follows practically the general course of the Chagres River, although at one point in the marshes below Bohio it is nearly two miles from the farthest bend in the river at a small place called Ahorca Lagarto. Bohio is about seventeen miles from the Atlantic terminus and Obispo about thirty miles. At the latter point the course of the Chagres River, passing up stream, lies to the northeast, while the general direction of the canal line is southeast toward Panama, the latter leaving the former at this location. The canal route follows up the general course of a small stream, called the Camacho, for a distance of nearly five miles where the continental divide is found, and in which the great Culebra cut is located about thirty-six miles from Colon and thirteen miles from the Panama terminus. After passing through the Culebra cut the canal route follows the course of the Rio Grande River to its mouth at Panama Bay. The mouth of the Rio Grande where the canal line is located, is about a mile and a half westerly of the city of Panama. The Rio Grande is a small, sluggish stream throughout the last six miles of its course, and for that distance the canal excavation would be made mostly in soft silt or mud.

Although the line selected by the French company is that adopted by the Isthmian Canal Company for its purposes a number of most important features of the general plan have been materially modified by the commission, as will be easily understood from what has already been stated in connection with the French plans.

The feasibility of a sea-level canal but with a tidal lock at the Panama end was carefully considered by the commission, and an approximate estimate of the cost of completing the work on that plan was made. In round numbers this estimated cost was about $250,000,000, and the time required to complete the work would probably be nearly or quite twice that needed for the construction of a canal with locks. The commission therefore adopted a project for the canal with locks. Both plans and estimates were carefully developed in accordance therewith.

The harbor of Colon has been fairly satisfactory for the commerce of that port, but it is open to the north and there are probably two or three days in every year during which northers blow into the harbor with such intensity that ships anchored there must put to sea in order to escape damage. The western limit of this harbor is an artificial point of land formed by material deposited by the old Panama Canal Company; it is called Christoph Colomb and near its extreme end are two large frame residences built for de Lesseps. The entrance to the canal is immediately south of this artificial point. The commission

projected a canal entrance from the six fathom contour in the Bay of Limon, in which the harbor of Colon is found, swinging on a gentle curve 6,560 feet radius to the left around behind the artificial point just mentioned and then across the shore line to the right into the low land southerly of Colon. This channel has a width of 500 ft. at the bottom, with side slopes of one on three, except on the second curve, which is somewhat sharper than the first, where the bottom width is made 800 ft. for a length of 800 ft. for the purpose of a turning basin. This brings the line into the canal proper, forming a well-protected harbor for nearly a mile inside of the shore line. The distance from

HARBOR OF COLON.

the six fathom line to this interior harbor is about two miles. The total cost of constructing the channel into the harbor and the construction of the harbor itself is $8,057,707, and the annual cost of maintenance is placed at $30,000. The harbor would be perfectly protected from the northers, which occasionally blow with such intensity in the Bay of Limon, and it could be made in all weathers by steam vessels seeking it.

The harbor at the Pacific end of the channel where it joins Panama Bay is of an entirely different character in some respects. The Bay of Panama is a place of light winds. Indeed it has been objected that the difficulties sometimes experienced by sailing vessels in finding

wind enough to take them out of Panama Bay are so serious as to constitute a material objection to the location for a ship canal on the Panama route. This difficulty undoubtedly exists at times, but the simple fact is to be remembered that Panama was a port for sailing ships for more than two hundred years before a steamship was known. The harbor of Panama, as it now exists, is a large area of water at the extreme northern limit of the bay, immediately adjacent to the City of Panama, protected from the south by the three islands of Perico, Naos and Culebra. It has been called a roadstead. There is good anchorage for heavy draft ships, but for the most part the water is shallow. With the commission's requirement of a minimum depth of water of 35 feet, a channel about four miles long from the mouth of the Rio Grande to the six-fathom line in Panama Bay must be excavated. This channel would have a bottom width of 200 feet with side slopes of one on three where the material is soft. Considerable rock would have to be excavated in this channel. At 4.41 miles from the six fathom line is located a wharf at the point called La Boca. A branch of the Panama Railroad Company runs to this wharf, and at the present time deep draft ships lie up alongside of it and take on and discharge cargo, as do the trains of the Panama Railroad Company. This wharf is a steel framed structure, founded upon steel cylinders, carried down to bedrock by the pneumatic process. Its cost was about $1,284,000. The total cost of this excavated channel, leading from Panama Harbor to the pier at La Boca, is estimated by the commission at $1,464,513. As the harbor at Panama is considered an open roadstead, it requires no estimate for annual cost of maintenance.

Starting from the harbor of Colon the prism of the canal is excavated through the low and for most part marshy ground to the little village called Bohio. The prism would cut the Chagres River at a number of points, and would require a diversion channel from that river for a distance of about five miles on the westerly side of the canal. Levees or protective embankments would also be required on the same side of the canal between Bohio and Gatun, the Chagres River leaving the canal line at the latter point on its way to the sea.

The principal engineering feature of the entire route is found at Bohio; it is the great dam across the Chagres River at that point, forming Lake Bohio, the summit level of the canal. The new Panama Canal Company located this dam at a point about seventeen miles from Colon, and designed to make it an earth structure suitably paved on its faces, but without any other masonry feature. Some borings had been made along the site and test pits were also dug by the French engineers. It was the conviction of the Isthmian Canal Commission, however, that the character of the proposed dam might be affected by

a further examination of the sub-surface material at the site. Consequently the boring parties of the commission sunk a large number of bore holes at six different sections or possible sites along the river in the vicinity of the French location. These borings revealed great irregularity in the character and disposition of the material below the bed and banks of the river. In some places the upper stratum of material was almost clear clay, and in other places clear sand, while all degrees of admixture of clay and sand were also found. At the French site the bedrock at the deepest point was found 143 ft. below sea level, with large masses of pervious and semi-pervious sand, gravel, and mixtures of those materials with clay. Apparently there is a geological valley in the rock along the general course of the Chagres River in this vicinity filled with sand, gravel and clay, irregularly distributed and with all degrees of admixture, large masses in all cases being of open texture and pervious to water. The site adopted by the commission for the purpose of its plans and estimates is located nearly half a mile down the course of the river from that selected by the new Panama Canal Company. The geological valley is nearly 2,000 ft. wide at this location, but the deepest rock disclosed by the borings of the commission is but 128 ft. below sea-level. The actual channel of the river is not more than 150 ft. wide and lies on the extreme easterly side of the valley. The easterly or right bank of the river at this place is clean rock and rises abruptly to an elevation of about 40 ft. above the river surface at ordinary stages. The left or westerly bank of the river is compact clay and sand and rises equally as abruptly as the rocky bank of the other side, and to about the same elevation. From the top of the abrupt sandy clay bank a plateau of rather remarkable uniformity of elevation extends for about 1,200 ft. in a southwesterly direction to the rocky hill in which the Bohio locks would be located. The rock slope on the easterly or northerly bank of the river runs down under the sandy river bed, but at such an inclination that within the limits of the channel the deepest rock is less than 100 ft. below sea-level.

After the completion of all its examinations and after a careful study of the data disclosed by them, the commission deemed it advisable to plan such a dam as would cut off absolutely all possible sub-surface flow or seepage through the sand and gravel below the river surface. It is to be observed that such a sub-surface flow might either disturb the stability of an earth dam or endanger the water supply of the summit level of the canal or both. The plan of dam finally adopted by the commission for the purposes of its estimates is shown by the accompanying plans and sections. A heavy core wall of concrete masonry extends from bed rock across the entire geological valley to the top of the structure, or to an elevation of 100 ft. above sea-level, thus absolutely closing the entire valley against any possible flow. The thickness of this wall

at the bottom is 30 ft., but at an elevation of 30 ft. below sea-level its sides begin to batter at such a rate as to make the thickness of the wall 8 ft. at its top. On either side of this wall are heavy masses of earth embankment of selected material properly deposited in layers with surface slopes of one on three. As shown by the plans the lower portions of the core wall of this dam would be sunk to bed rock by the pneumatic process, the joints between the caissons being closed and sealed by concrete and by cylinders sunk in recesses or wells, also as shown by the plans.

The profile of this route shows that the summit-level would have an ordinary elevation of 85 ft. above the sea, but it may be drawn down for uses of the canal to a minimum elevation of 82 ft. above the same datum. On the other hand, under circumstances to be discussed later, it may rise during the floods of the Chagres to an elevation of 90 or possibly 91 or 92 ft. above the level of the sea. The top of the dam therefore would be from 8 to 10 ft. above the highest possible water surface in the lake, which is sufficient to guard against wash or overtopping of the dam by waves. The total width of the dam at its top would be 20 ft., and the entire inner slope would be paved with heavy rip-rap suitably placed and bedded.

This dam would create an artificial lake having a superficial area during high water of about 40 sq. miles. The water would be backed up to a point called Alhajuela, about twenty-five miles up the river from Bohio. For a distance of nearly fourteen miles, *i. e.*, from Bohio to Obispo, the route of the canal would lie in this lake. Although the water would be from 80 to 90 ft. deep at the dam, for several miles below Obispo it would be necessary to make some excavation along the general course of the Chagres in order to secure the minimum depth of 35 ft. for the navigable channel.

The feature of Lake Bohio of the greatest importance to the safe and convenient operation of the canal is that by which the floods of the River Chagres are controlled or regulated. That river is but little less than 150 miles long, and its drainage area, as nearly as can be estimated, contains about 875 sq. miles. Above Bohio its current moves some sand and a little silt in times of flood, but usually it is a clear water stream. In low water its discharge may fall to 350 cubic feet per second.

As is well known, the floods of the Chagres have at times been regarded as almost if not quite insurmountable obstacles to the construction of a canal on this line. The greatest flood of which there is any semblance of a reliable record is one which occurred in 1879. No direct measurements were made, but it is stated with apparent authority that the flood elevation at Bohio was 39.3 ft. above low water. If the total channel through which the flood flowed at that time had been as large as at present, actual gaugings or measurements of subsequent floods

show that the maximum discharge in 1879 might have been at the rate of 136,000 cu. ft. per second. As a matter of fact the total channel section in that year was less than it is at the present time. Hence if it be assumed that a flood of 140,000 cu. ft. per second must be controlled an error on the safe side will be committed. Other great floods of which there are reliable records are as follows:

1885—Height at Bohio 33.8 ft. above low water.
1888—Height at Bohio 34.7 ft. above low water.
1890—Height at Bohio 32.1 ft. above low water.
1893—Height at Bohio 28.5 ft. above low water.

The maximum measured rate of the 1890 flood was 74,998 cu. ft. per second, and that of 1893, 48,975 cu. ft. per second. It is clear therefore that a flood flow of 75,000 cu. ft. per second is very rare, and that a flood of 140,000 cu. ft. per second exceeds that of which we have any record for practically forty years.

It is obvious that the dam, as designed by the commission, is of such a character that no water must be permitted to flow over its crest, or even in immediate proximity to the downstream embankment. Indeed it is not intended by the Commission that there shall be any waste way or discharge anywhere near the dam. At a point about three miles southwest of the site of the dam at Bohio is a low saddle or notch in the hills near the headwaters of a small stream called the Gigante River. The elevation of this saddle or notch is such that a solid masonry weir with a crest 2,000 ft. long may readily be constructed with its foundation on bed rock without deep excavation. This structure is called the Gigante Spillway, and all surplus flood waters from the Chagres would flow over it. The waters discharged would flow down to and through some large marshes, one called Pena Blanca and another Agua Clara before rejoining the Chagres. Inasmuch as the canal line runs just easterly of those marshes it would be necessary to protect it with the levees or embankments to which allusion has already been made. These embankments are neither much extended nor very costly for such a project. The protection of the canal would be further aided by a short artificial channel between the two marshes, Pena Blanca and Agua Clara, for which provision is made in the estimates of the commission. After the surplus waters from the Gigante Spillway pass these marshes they again enter the Chagres River or flow over the low, half-submerged country along its borders, and thence through its mouth to the sea near the town of Chagres about six miles northwest of Gatun.

The masonry crest of the Gigante Spillway would be placed at an elevation of 85 ft. above the sea, identically the same as that which may be called the normal summit level of the canal. It is estimated that the total uses of water in the canal added to the loss by evaporation taken

at six inches in depth per month from the surface of the lake will amount to about 1,070 cu. ft. per second if the traffic through the canal should amount to 10,000,000 tons per annum in ships of ordinary size. This draft per second is the sum of 406 cu. ft. per second for lockage, 207 for evaporation, 250 for leakage at the lock gates and 200 for power and other purposes, making a total of 1,063, which has been taken as 1,070 cu. ft. per second. The amount of storage in Lake Bohio between the elevations of 85 and 82 ft. above sea-level, as designed, is sufficient to supply the needs of that traffic in excess of the smallest recorded low-water flow of the Chagres River during the dry season of a low rainfall year. The lowest monthly average flow of the Chagres on record at Bohio is 600 cu. ft. per second for March, 1891, and for the purposes of this computation that minimum flow has been supposed to continue for three months. This includes a sensible margin of safety. In not even the driest year therefore can it be reasonably expected that the summit level of the canal would fall below the elevation of 82 ft. until the total traffic of the canal carried in ships of the present ordinary size shall exceed 10,000,000 tons. If the average size of ships continues to increase, as will probably be the case, less water in proportion to tonnage will be required for the purposes of lockage. This follows from the fact that with a given tonnage the greater the capacity of the ships the less the number required, and consequently the less will be the number of lockages made.

On the other hand it can be shown that with a depth of five feet of water on the crest of the Gigante Spillway the discharge of that weir 2,000 ft. long will be at the rate of 78,260 cu. ft. per second. If the flood water of the Chagres should flow into Lake Bohio until the head of water on the crest of the Gigante weir rises to 7.5 ft. the rate of discharge over that weir would be 140,000 cu. ft. per second, which, as already shown, exceeds at least by a little the highest flood rate on record. The operation of Lake Bohio as a flood controller or regulator is therefore exceedingly simple. The flood waters of the Chagres would pour into the lake and immediately begin to flow over the Gigante weir, and continue to do so at an increasing rate as the flood continues. The discharge of the weir is augmented by the increasing flood and decreases only after the passage of the crest of the flood wave. No flood even as great as the greatest supposable flood on record can increase the elevation of the lake more than 92 to 92.5 ft. above sea-level, and it will only be at long intervals of time that floods will raise that elevation more than about 90 ft. above sea level. The control is automatic and unfailingly certain. It prevents absolutely any damage from the highest supposable floods of the Chagres, and reserves in Lake Bohio all that is required for the purposes of the canal and for wastage by evaporation through the lowest rainfall season. The floods

of the Chagres, therefore, instead of constituting the obstacle to construction and convenient maintenance of the canal heretofore supposed are deprived of all their prejudicial effects and transformed into beneficial agents for the operation of the waterway.

The highest floods are of short duration, and it can be stated as a general law that the higher the flood the shorter its duration. The great floods which it is necessary to consider in connection with the maintenance and operation of this canal would last but a comparatively few hours only. The great flood flow of 140,000 cu. ft. per second would increase the current in the narrowest part of the canal below Obispo to possibly 5 ft. per second for a few hours only, but that is the only inconvenience which would result from such a flood discharge. That velocity could be reduced by additional excavation.

Inasmuch as this system of control, devised and adopted by the Isthmian Canal Commission, is completely effective in regulating the Chagres floods, the reservoir proposed to be constructed, by the new Panama Canal Company at Alhajuela on the Chagres about twelve miles above Obispo, is not required, and the cost of its construction would be avoided. It could, however, as a project be held in reserve. If the traffic of the canal should increase to such an extent that more water would be needed for feeding the summit level the dam could be built at Alhajuela so as to impound enough additional water to accommodate, with that stored in Lake Bohio, at least five times the 10,000,000 annual traffic already considered. Its existence would at the same time act with substantial effect in controlling the Chagres floods and relieve the Gigante Spillway of a corresponding amount of duty.

The locks on the Panama route are designed to have the same dimensions as those in Nicaragua, as was stated in the lecture on that route. The usable length is 740 ft. and the clear width 84 ft. They would be built chiefly of concrete masonry while the gates would be of steel, and of the mitre type.

The great dam at Bohio raises the water surface in the canal from sea-level in the Atlantic maritime section to an ordinary maximum of 90 ft. above sea-level; in other words, the maximum ordinary total lift would be 90 ft. This total lift is divided into parts of 45 ft. each. There is therefore a flight of two locks at Bohio, indeed there are two flights side by side as the twin arrangement is designed to be used at all lock sites on both routes. The general dimensions and the arrangements of these locks with the requisite culverts and other features are shown in the acompanying plans and sections. They are not essentially different from other great modern ship canal locks. The excavation for the Bohio locks is made in a rocky hill against which the southwesterly end of the proposed Bohio dam rests and they are less than one thousand feet from it.

After leaving Bohio Lake, at Obispo, a flight of two locks is found at Pedro Miguel, about 7.9 miles from the former or 21.5 miles from Bohio. These locks have a total ordinary maximum lift of 60 ft., divided into two lifts of 30 ft. each. The fifth and last lock on the route is at Miraflores. The average elevation of water between Pedro Miguel and Miraflores is 30 ft. above mean sea-level. Inasmuch as the range of tide between high and low in Panama Bay is about 20 ft. the maximum lift at Miraflores is 40 ft. and the minimum about 20. The twin locks at Miraflores bring the canal surface down to the Pacific Ocean level, the distance from those locks to the six-fathom curve in Panama Bay being 8.45 miles. There are therefore five locks on the Panama route, all arranged on the twin plan, and, as on the Nicaragua route, all are founded on rock.

Near Obispo a pair of guard gates are arranged 'so that if it should become necessary to draw off the water from the summit cut the level of Lake Bohio would not be affected.'

An unprecedented concentration of heavy cutting is found between Obispo and Pedro Miguel. This is practically one cut although the northwesterly end toward Obispo is called the Emperador while the deepest part at the other end, about three miles from Pedro Miguel, is the great Culebra cut with a maximum depth on the center line of the canal of 286 ft. On page 93 of the Isthmian Canal Commission's report is the following reference to the material in this cut:

> There is a little very hard rock at the eastern end of this section, and the western two miles are in ordinary materials. The remainder consists of a hard indurated clay, with some softer material at the top and some strata and dikes of hard rock. In fixing the price it has been rated as soft rock, but it must be given slopes equivalent to those in earth. This cut has been estimated on the basis of a bottom width of 150 feet, with side slopes of one on one.

When the old Panama Canal Company began its excavation in this cut considerable difficulty was experienced by the slipping of the material outside of the limits of the cut into the excavation, and the marks of that action can be seen plainly at the present time. This experience has given an impression that much of the material in this cut is unstable, but that impression is erroneous. The clay which slipped in the early days of the work was not drained, and like wet clay in numerous places in this country it slipped down into the excavation. This material is now drained and is perfectly stable. There is no reason to anticipate any future difficulty if reasonable conditions of drainage are maintained. The high faces of the cut will probably weather to some extent, although experience with such clay faces on the isthmus indicates that the amount of such action will be small. As a matter of fact the material in which the Culebra cut is made is stable and will give no sensible difficulty in maintenance.

(*To be continued.*)

PRINCETON IN THE NATION'S SERVICE.*

By President WOODROW WILSON,
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I HAVE no laboratory but the world of books and men in which I live; but I am much mistaken if the scientific spirit of the age is not doing us a great disservice, working in us a certain great degeneracy. Science has bred in us a spirit of experiment and a contempt for the past. It has made us credulous of quick improvement, hopeful of discovering panaceas, confident of success in every new thing.

I wish to be as explicit as carefully chosen words will enable me to be upon a matter so critical, so radical as this. I have no indictment against what science has done: I have only a warning to utter against the atmosphere which has stolen from laboratories into lecture rooms and into the general air of the world at large. Science—our science—is new. It is a child of the nineteenth century. It has transformed the world and owes little debt of obligation to any past age. It has driven mystery out of the Universe; it has made malleable stuff of the hard world, and laid it out in its elements upon the table of every class-room. Its own masters have known its limitations; they have stopped short at the confines of the physical universe; they have declined to reckon with spirit or with the stuffs of the mind, have eschewed sense and confined themselves to sensation. But their work has been so stupendous that all other men of all other studies have been set staring at their methods, imitating their ways of thought, ogling their results. We look in our study of the classics nowadays more at the phenomena of language than at the movement of spirit; we suppose the world which is invisible to be unreal; we doubt the efficacy of feeling and exaggerate the efficacy of knowledge; we speak of society as an organism and believe that we can contrive for it a new environment which will change the very nature of its constituent parts; worst of all, we believe in the present and in the future more than in the past, and deem the newest theory of society the likeliest. This is the disservice scientific study has done us; it has given us agnosticism in the realm of philosophy, scientific anarchism in the field of politics. It has made the legislator confident that he can create, and the philosopher sure that God cannot. Past experience is discredited, and the laws of matter are supposed to apply to spirit and the make-up of society.

* Concluding part of the oration at the Princeton Sesquicentennial Exercises. Reprinted from *The Forum* for December, 1896.

Let me say once more, this is not the fault of the scientist; he has done his work with an intelligence and success which cannot be too much admired. It is the work of the noxious, intoxicating gas which has somehow got into the lungs of the rest of us from out of the crevices of his workshop—a gas, it would seem, which forms only in the outer air, and where men do not know the right use of their lungs. I should tremble to see social reform led by men who had breathed it; I should fear nothing better than utter destruction from a revolution conceived and led in the scientific spirit. Science has not changed the laws of social growth or betterment. Science has not changed the nature of society, has not made history a whit easier to understand, human nature a whit easier to reform. It has won for us a great liberty in the physical world, a liberty from superstitious fear and from disease, a freedom to use nature as a familiar servant; but it has not freed us from ourselves. It has not purged us of passion or disposed us to virtue. It has not made us less covetous or less ambitious or less self-indulgent. On the contrary, it may be suspected of having enhanced our passions, by making wealth so quick to come, so fickle to stay. It has wrought such instant, incredible improvement in all the physical setting of our life, that we have grown the more impatient of the unreformed condition of the part it has not touched or bettered, and we want to get at our spirits and reconstruct them in like radical fashion by like processes of experiment. We have broken with the past and have come into a new world.

Can any one wonder, then, that I ask for the old drill, the old memory of times gone by, the old schooling in precedent and tradition, the old keeping of faith with the past, as a preparation for leadership in days of social change? We have not given science too big a place in our education, but we have made a perilous mistake in giving it too great a preponderance in method over every other branch of study. We must make the humanities human again; must recall what manner of men we are; must turn back once more to the region of practicable ideals.

Of course, when all is said, it is not learning, but the spirit of service, that will give a college place in the public annals of the Nation. It is indispensable, it seems to me, if it is to do its right service, that the air of affairs should be admitted to all its class-rooms. I do not mean the air of party politics, but the air of the world's transactions, the consciousness of the solidarity of the race, the sense of the duty of man toward man, of the presence of men in every problem, of the significance of truth for guidance as well as for knowledge, of the potency of ideas, of the promise and the hope that shine in the face of all knowledge. There is laid upon us the compulsion of the National life. We dare not keep aloof and closet ourselves while a nation comes

to its maturity. The days of glad expansion are gone; our life grows tense and difficult; our resource for the future lies in careful thought, providence and wise economy; and the school must be of the Nation.

I have had sight of the perfect place of learning in my thought, a free place and a various, where no man could be and not know with how great a destiny knowledge had come into the world—itself a little world; but not perplexed, living with a singleness of aim not known without; the home of sagacious men, hard-headed and with a will to know, debaters of the world's questions every day and used to the rough ways of democracy; and yet a place removed—calm Science seated there, recluse, ascetic, like a nun, not knowing that the world passes, not caring, if the truth but come in answer to her prayer; and Literature, walking within her open doors, in quiet chambers, with men of olden time, storied walls about her, and calm voices infinitely sweet; here 'magic casements, opening on the foam of perilous seas, in fairy lands forlorn,' to which you may withdraw and use your youth for pleasure; there windows open straight upon the street, where many stand and talk, intent upon the world of men and business. A place where ideals are kept in heart in an air they can breath; but no fool's paradise. A place where to hear the truth about the past and hold debate about the affairs of the present, with knowledge and without passion; like the world in having all men's life at heart, a place for men and all that concerns them; but unlike the world in its self-possession, its thorough way of talk, its care to know more than the moment brings to light; slow to take excitement, its air pure and wholesome with a breath of faith; every eye within it bright in the clear day and quick to look toward heaven for the confirmation of its hope. Who shall show us the way to this place?

THE ANTILLEAN VOLCANOES.

By. Dr. W J McGEE,
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IN all ages volcanoes have played a prominent rôle in human thought The Vulcan of classic mythology was but the head of a family of earth-gods born of the polytechnic Mediterranean mind fertilized by the "burning mountains" of continents conjoined in the Levant; and in the still lower stages of human development represented by scores of surviving tribes, Fire-Earth deities head the primitive pantheons—indeed, the Vulcanean notion seems to run back to a pristine stage in which the forerunners of living races first stole Vulcan's torch, tamed capricious and ferocious fire even as other [to them] beasts were tamed, and thus took the initial step in that nature-conquest by which man rose above lower life. Certain it is that Vulcanean myths are most dominant in lower savagery, feebler albeit sharper-cut about the birth-time of writing, and decadent during the period of written history. Naturally a factor in the eclipse of Vulcan was the dispersion of mankind, largely in accordance with preconceived plans, from the volcanic centers in which fire was first enslaved over volcano-free regions in which the new servant was thralled by new devices; and it is significant that not only the beast-gods of the prime but the later nature-deities, like Jove and Pluto, Thor and Odin, were swept away before the tide of self-confidence raised by nature-conquest. So Vulcan and the rest lost their terrors; they even fell into oblivion like the beast-gods before, save as the chaff of concepts caught in the meshes of scripture. Most of the mythic monsters are gone utterly; yet Vulcan dies hard—and now and then the nature power for which he stands rises above all human might, and tempts men to return to that early stage of thought marked by the personification of powers.

The latest Vulcanean throes have caught the attention of the reading world. Measured by volume of material cast out, or by force of explosions, the recent Antillean outbreaks rank below many others on record—far below the stupendous outbursts of later geologic periods; yet measured by mortality, the eruption of Mont Pelee on the morning of May 8, 1902, ranks among the most appalling catastrophes of history. And never before was news of disaster so quickly spread; quick thinkers jotted the details, and cables and swift ships carried them to every country within a few hours—yet not so speedily but that history's brightest example of practical sympathy overtook the echoes

of calamity. The prompt charity was not emotional merely, but a material outpouring of national substance; and it was no less rational, as attested by the presence on the relief ships of a corps of scientific students whose aim was to dispense knowledge with food and apparel, and to acquire better knowledge against future emergencies. Measured merely by mortality, Mont Pelee marks one of the darkest chapters in human history; measured by the upwelling of human sympathy, it stands for one of the brightest chapters; and measured by the prompt and effective inauguration of research, it must be said to open a new chapter in vulcanology.

The destruction of St. Pierre on the morning of May 8 was one of a series of episodes closely connected in time if not in cause. The chain began with eruptions from the long quiescent crater of Colima (western Mexico) late last year; then followed a series of earthquakes in Mexico and Central America, culminating in the shocks which wrecked Guatemala City and ruined Quetzaltenango on April 18; this shock was apparently followed immediately by steam spits from the crater of Mont Pelee (the culminating mountain mass of Martinique), which had been quiet since 1851, and also from La Souffriere, the commanding crater of the island of St. Vincent, which had rested since 1812. The steam puffs grew in magnitude, and before the end of April there were several explosions, accompanied by rumblings and tremblings of the earth, in which jets of mud were shot into the air and swept far a-sea by the trade-winds; while the warm springs and solfataras (or souffrieres) on Martinique and other islands displayed unwonted activity. The manifestations increased during the early days of May, and Professor Landes, of the Lycée de St. Pierre, detected gases of subterranean origin in the air and erupted material, and sent a note of danger to the Colonial Governor of Martinique. Most unhappily lulled by the memory of the innocent eruption of 1851, the official enjoined secrecy, and appointed a commission of inquiry, whose report did much to allay apprehension and keep St. Pierre crowded for the approaching holocaust. On May 5 there was a destructive eruption from Mont Pelee; clouds of rock-powder were blown high in the air, the rivers overflowed with scalding floods and a stream of hot mud engulfed a sugar factory—L'Usée Guerin—with a score of attachés. Still the Governor forbade the evacuation of St. Pierre; and when, on May 7, the great Souffriere on St. Vincent exploded with a violence exceeding all record, cables were broken and other means of communication interrupted, so that St. Pierre continued to await her doom with hardly ruffled composure. On the morning of May 8, Mont Pelee burst at top and side with a terrific detonation; the earth trembled, and for a few moments the people of the city and the sailors on the shipping in

the roadstead began to seek safety; then a gale of burning gas and a rain of red-hot rock fell, and all St. Pierre, with fifteen of the seventeen vessels at anchor, were destroyed in an instant. Neighboring villages were blotted out; all Martinique was shaken; the detonation rolled out over the waves two hundred miles in every direction; the column of steam and rock-powder rose miles in height, and the dust was scattered over more than a hundred thousand square miles of isle-dotted ocean. This outbreak was not the end, nor even the culmination; La Souffriere continued to belch steam and mud, and Mont Pelee to erupt daily if not hourly, the explosion of May 20 exceeding in violence those of all earlier dates; and the magnetic disturbances accompanying the severer shocks were recorded in Maryland and Kansas, in Paris, and according to one report in Honolulu. The long quiescent crater of Tacana (Guatemala) was stirred into explosive activity; the warm springs of New Mexico resumed the long-past geyser form, and the crater near Grant, dead for five centuries, steamed anew; Mount Redoubt and neighboring craters in Washington State resumed alarming activity, and rumors of fresh outbreaks in Alaskan volcanoes gained currency; and the latest reports indicate that Kilauea, in Hawaii, has joined the concert. These are but the best-known links in the chain of sequence; it may not yet be affirmed that this succession is more than one of time, yet it is significant that the localities swept by the chain are all within reach of the magnetic disturbances extending for thousands of miles from Mont Pelee.

The eruption of Colima cost a number of lives not yet counted; the mortality at Quetzaltenango and neighboring places is estimated at 2,000 or more; the outbreak of Tacana is reported to have cost over a thousand lives; La Souffriere slew some two thousand; St. Pierre lost all of her 25,000, and other villages on Martinique some seven thousand more; so that Vulcan's victims in a single province during April and May, 1902, must approach 40,000. The number will never be accurately known; for there are no censuses covering certain Central American districts and some others in which the fatalities were numerous.

The lesson of Mont Pelee and St. Pierre is especially instructive. The researches of Hill, Russell, Heilprin, Jaggar, Borchgrevink, Hovey and Kennan have already made fairly clear the external aspects of the great eruption. Northern Martinique, like other West Indian islands, is a labyrinth of mornes and pitons, *i. e.*, of singularly steep peaks and ridges (partly volcanic cones, partly erosional forms), densely clothed with forests and herbage; it culminates in the crater rim of Mont Pelee a little less than 5,000 feet in altitude, with a sinuous divide extending southward and minor aretes stretching sea-

ward between the gorges of radiating waterways. In general, the mass of northern Martinique bulges upward and outward, a great dome convex toward the sky; but west and southwest of the summit crater there is an irregularly triangular amphitheater, of a form suggesting that a segment of the mountain has dropped several hundred feet below the general contour. At the coast line this depression forms the shallow bay of St. Pierre roadstead; and thence to the crest the depressed segment is bounded by rocky walls—sharp divides, cliffs, and lines of mornes, in different places. Almost in the center of this triangular trough sloping down from Pelee crater to the sea stood the city of St. Pierre, the metropolis of Martinique—that gem of the Antilles which must always live in history as the birthplace of Josephine, the early home of Bernardin de St. Pierre and the real scene (through youthful associations) of the epic of Paul and Virginia. St. Pierre was, indeed, an Antillean metropolis, the abode of culture and refinement, a mart of trade and shipping, the site of educational institutions of no mean grade, a city whose strong and distinctive characters were well worthy the gifted pen of its best chronicler, Lafcadio Hearn. Up the steep slopes toward the idly gaping crater four miles away, ran well beaten footpaths (for horses and wheels are alien to the precipitous slopes of the Antilles) leading to plantations and on to suburban villages, Carbet on the south, Precheur on the northern boundary of the amphitheater, Morne Rouge on the divide stretching away from the crater. The colonial Jardin Botanique lay in the rear, some hundred feet above the city; luxuriant cane-fields covered every available spot, groves and rows of palms skirted streets and pathways, legion brooks carried living water from the upper slopes to the sea, and thick native verdure mantled all the surface save fields and paths. Some half-way down the trough from Pelee to St. Pierre stood a minor crater, with traces of fumaroles; but they were covered from sight and memory by the prevailing verdure. A picturesque pond lay at the bottom of the great crater; and much of the water flowing seaward from the verdure-clad hills of the trough gathered into a central stream, La Riviere Blanche. Such was the area of destruction.

It is probable that the explosion of May 5 vaporized the water of the crater-set pond, and blew it into the air; it is also probable that the minor crater half-way down the slope toward St. Pierre was at least partially opened. More certain it is that on the morning of May 8 a mass of molten rock in the throat of the great crater exploded by the flashing into gas of the water and other volatile substances approaching the surface and so escaping subterranean pressure; and that immediately afterward (probably timed by the disturbed air pressure due to the first discharge) the minor crater fired a smaller

blast. In any event, steam, smoke, rock-dust, pumice bombs, and great blobs of half-liquid rock shot skyward from the main crater, with an earth-tremor of startling but not wrecking severity—and this discharge, extending miles into the upper air, must have initiated a series of atmospheric pressure waves; and about the time the heavier dust and bombs began to fall, or just in time to meet the recurrent wave of atmospheric pressure, the discharge of steam and other gases from the minor crater occurred. Some at least of these gases were heavier than air, and formed a black cloud which rolled down the amphitheater toward St. Pierre; according to several witnesses cross-examined by Hill, it was dense and black in front, aflame in the rear; and under the shock of the recurrent air-waves above, it was driven down on St. Pierre with such velocity that roofs flew before it like chaff, the lighthouse tower was twisted and rent into débris, heavy cannon were lifted from their carriages, and a 7-ton metal monument was blown forty yards; every vessel at anchor was careened and most of them capsized, anchor-chains were broken, and an off-shore wave was driven out of the road-stead to return in a destructive debacle. Disturbed by the initial quake, the people of the city fled to the cathedral or local shrines, sought refuge in fancied strongholds, or ran aimlessly about; when caught by the black cyclone, they were thrown against walls and amidst wreckage, bruised and burned by the red-hot rocks pouring from above, and suffocated by sulphurous fumes; then, when the gas-cloud caught fire from its own lightning or from molten rock, every living thing was scorched, seared or baked according to the local conditions of the burning. Such is the picture painted by Hill from the testimony of survivors of the *Roddam* and the *Roraima,* and of the parish priest and others who looked down on the holocaust from the cliffs flanking the St. Pierre amphitheater; Russell ascribes less effect to burning gas and more to scorching rock-powder; Borchgrevink emphasizes the evidence of electro-magnetic disturbance; but all agree that the scourge of St. Pierre was fire rather than earthquake or Pompeiian burial. The tragedy was not absolutely instantaneous; yet within three to ten minutes, the thirty thousand of St. Pierre and environs—Professor Landes, the prophetic scientist, and the misguided Governor among the rest—were no more. Thousands of bodies cumbered the debris-strewn streets or lay in the shattered houses until May 20, when Pelee again thundered—and then buried the reeking wreckage beneath a fresh layer of rock-powder. The later eruptions, like the initial one, usually combined an explosion from the main crater with an immediately subsequent one from the subordinate crater; and they sent out clouds whose movements helped to interpret those of earlier date. Thus, on May 23 Hill was able to study from below a gas-cloud like that which fell on St. Pierre; and he was even able (after realizing

the futility of attempting escape) to photograph the swirling tongue of flame by which the cloud was rent, and this picture must some day tell whether the fire was lightning or the combustion of inflammable gas.

Other external features of the Vulcanean throes, especially in Mont Pelee, were the detonations heard 200 miles away (those of Krakatoa were audible over 1,000 miles in all directions, almost 3,000 in one); the seismic tremors felt throughout most of the Lesser Antilles; the magnetic shock noted by suitably equipped laboratories from Paris to Honolulu, or a full third of the way about the globe; and especially the solid and gaseous ejectamenta discharged skyward and distributed hundreds of miles in every direction. At Fort de France it was estimated that the greater discharges rose six miles from the crater, seven miles above the level of the sea; by triangulation Bernadou determined the height of the minor discharge of May 30 at 15,500 feet, or something less than three miles (the mean estimate of the height of the Krakatoan discharge in 1883 was 17 miles). The cloud of steam and other gases, with their burden of rock-powder, spread in typical mushroom shape with such rapidity that neighboring islands up to a hundred miles away were darkened, and the dust-rain began to fall within three hours; on Barbados, 100 miles from La Souffriere and 125 from Mont Pelee, the dust-rain reached a depth of a quarter of an inch, and brought down sulphurous gases. The early analyses indicate that the greater part of this material is a crystalline hypersthene-andesite, *i. e.*, the heavier portion of a rather acidic lava of which the more glassy portions are thought by Teall 'to have been vanned away and deposited elsewhere' (*Nature*, Vol. 66, p. 130); while according to Diller and Steiger some of the grains collected 275 miles southeast of St. Vincent have the astonishingly high specific gravity of 3.3, and the insoluble dust contained .11 per cent. of sulphur, while the dust collected on Barbados was notable for the abundance of magnetite (*Science*, Vol. XV., pp. 947–950). Nearer the crater of Mont Pelee, the dust—'ashes' of the press reports, 'lapilli' of the books—lies like snow in drifts and sheets sometimes several feet in depth, and is mingled with fragments of pumice or bombs of denser rock, perhaps torn from the throat of the crater. Naturally the rock-rain was cool at Barbados and other remote stations; on St. Vincent, after the outbreak of La Souffriere, and on Martinique under each eruption of Mont Pelee, the falling rock was warm, even hot; an officer of one of the vessels wrecked in the roadstead of St. Pierre escaped the first shock only to be smitten down by a falling mass of half-molten rock; Russell found indications that some of the falling dust was hot enough to scorch the skin of victims but not to fire cotton garments; and a correspondent of *Nature* reiterates the incredible report that the sand

falling on St. Pierre, miles from the nearest crater, was still 'white hot.' All accounts agree as to the immensity and blackness of the clouds cast out from Mont Pelee with each explosion; and all agree in indicating that an important constituent of these clouds was gas, at least in part heavier than air, and at least in part inflammable. These eruptions are especially notable for the extravasation of material in gaseous form; but the gases have not yet been measured or even identified with any approach to precision. Thus far no quantitative estimates have been made of the aggregate amount of matter erupted from either Antillean volcano; but it seems probable that the total from both will not exceed one or two cubic miles, *i. e.*, probably less than a third of that thrown out by Krakatoa alone in the memorable outbreak of 1883. No decisive indications of subsidence of the coasts or of deformation of either insular masses or sea-bottom, such as might be expected to accompany the transfer of so vast a mass of material, have yet been detected—indeed, the geographic effects of the eruptions seem to be inconsiderable. Nor were there notable tidal waves anywhere in the Antillean region, save the outflows and subsequent inrushes in the St. Pierre harbor, ascribed by Hill to the atmospheric disturbance; and even these air-waves were of but limited extent, as indicated by the absence of records at meteorologic stations more remote than that on St. Kitt's, some 200 miles north of Martinique.

The most impressive part of Pelee's lesson is the tale of terrible mortality due to the ill-chosen site of St. Pierre. The convex slopes of the great dome stretching northward and eastward from the crater are still clad in verdure; Morne Rouge, the high-lying suburb on the principal salient stretching out from the crater, suffered nothing more serious than startling tremors and disagreeable dust-showers; it was only in the topographic funnel leading from the crater to the indented roadstead that the destruction was complete. Looking back over her history, it is easy to see that St. Pierre was founded with no more foresight than that of the spider spinning her web across a frequented path; the sacrifice of the city was but the necessary price of shortsight; yet if future dwellers on the Antilles, and the folk of other volcano-ridden regions, but profit by the experience of St. Pierre, the sacrifice may not be wholly vain.

So far as indicated by external manifestations, the internal mechanism of the Antillean volcanoes was in no way unprecedented or even peculiar, save, perhaps, in the high ratio of gaseous ejectamenta and the vast extent of magnetic disturbance and even these features may not be new, but only the outcome of more refined observations than those of earlier generations.

The internal mechanism of Mont Pelee and La Souffriere is fairly

clear in the light of what may be called the natural history of vulcanism; for, just as the life history of organic orders and genera is traced only by aid of fossils, so the ontogeny of the volcano may be viewed in the light of the phylogeny traced through its fossil remains—lava sheets, tuff beds, laccolites, volcanic necks like those of the Mount Taylor plateau, and other products of organic action during the ages past.

Naturally the first question concerning the volcano relates to its character; and this is answered partly by such dynamic facts as those recently observed in the Antilles, partly by the static records of the rocks. In the light of the various phenomena, it is convenient to recognize three types of eruption, viz: (1) the Stromboli type, or that of quiet outflow of highly fluent lava; (2) the type of Vesuvius, or that of explosive eruption usually followed by quieter flows of lava; and (3) the Krakatoa type, represented by violent explosions with little, if any, extravasation of lava. In some measure the types intergrade, the middle one, indeed, approaching the extremes; yet they are so connected with the character of the erupted material and other factors as to demand recognition.

The second inquiry concerning the world's volcanoes relates to geographic distribution; and this is well answered by any convenient map, such as that of Bonney (reproduced in the June number of this journal, page 187), from which it appears that nearly all of the living and recently extinct craters are arranged in lines, or zones, coinciding approximately with continental boundaries. Two of the most striking volcanic belts of the globe are those following the chain of Aleutian islands, and that of the Lesser Antilles from Porto Rico southward to the mouth of Orinoco river; several of the world's largest volcanoes occur in the interlacing zones lying off southeastern Asia; and the world's longest belt begins with the Aleutian chain, follows the coastwise mountains of western North America, traverses Central America, takes in the great Andean volcanoes of western South America, and stretches thence to Terra del Fuego, if not across to Antarctica to end with Mounts Erebus and Terror. The volcanic belts of the globe are sometimes styled 'lines of weakness' in the earth-crust, though a sufficient number of live or recently dead craters lie apart on oceanic islands or in continental interiors to caution conservative geologists against too simple groupings; yet all the facts seem to fall into the generalization that volcanic regions coincide with zones of exceptional activity in continent-making agencies.

A third inquiry concerning volcanoes relates to their geologic distribution, or—in ultimate analysis—to their connection with other geologic agencies and processes. The observations of numberless geologists in the different countries of the globe seem to answer this inquiry in general terms, by indicating that the agency of vulcanism is deca-

dent—that it culminated before the beginning of that definite world-growth recorded in the stratified rocks, revived locally during various periods down to the later Tertiary, and is probably less vigorous to-day than during any earlier eon of geologic time. Going further into detail, Powell has defined what may be called the normal sequence of vulcanism in any particular geologic province: The first stage in this sequence is that of loading, or accumulation of sediments in areas of deposition; the second is that of baking, compression, and metamorphosis of the lower sediments by the rise of the isogeotherms (measuring proper terrestrial heat); the third stage is that of uplift, partly by reason of the expansion and crumpling consequent on the heating from below; the fourth stage is that of unloading, or degradation by rain and rivers; and the final stage is that of vulcanism, supervening as the degradation proceeds and sometimes continuing until the province is once more submerged.

The distribution of volcanoes, both on the present earth-face and throughout the periods of earth-growth, covers essential phases of the natural history of vulcanism; yet the mechanism of the volcano remains to be traced through specific interpretation of both processes and products, so far as these lie within reach of observation. An epoch-marking step towards the interpretation of volcanic products was made by Baron von Richthofen a third of a century ago, when he recognized a natural system of volcanic rocks; and the goal was attained when Dutton, in a flash of genius, saw 'the double function of density and fusibility' ('Geology of the High Plateaus of Utah,' 1880, p. 137) which conditions the extrusion of molten rock-matter. Diller, Iddings, Lawson and others have extended the interpretation; yet the later researches have but established the inference that density, or specific gravity, and fusibility (itself affected by wetness) are leading factors in determining the mechanism of volcanic action. Briefly, it may be said (1) that the seat of normal volcanic action is deep in the earth-crust, so deep that the vertical column of denser sea-bottom rocks is heavier than the longer column of mountain rocks rising thence to the cratered crest; (2) that here the rock-matter is subjected to the enormous pressure of superincumbent miles of rock, yet so highly heated as to become mobile with any relief from pressure; (3) that by reason of the variable strains due to unloading or other causes, some portion of this confined rock-matter is sufficiently relieved from pressure to become mobile, whereupon it seeks the level determined by its density, and forces itself upward through any overlying strata of greater density in channels or vents enlarged by continuous flow; (4) that the molten rock arranges itself in the vent in the order of specific gravity, the lighter above, the heavier (and generally wetter) below; (5) that sometimes the upwelling stream of molten rock reaches

a hydrostatic equilibrium and spreads out in laccolites without ever reaching the surface, though normally it forces its way upward through the lightest rocks (and these are those of mountains) well toward the surface; and (6) that as the mass approaches the surface so closely as to find relief from the subterranean pressure, its volatile constituents (chiefly occluded water) flash into gas, usually with explosive violence. Now if the lava column is of exceptionally viscous material, either because exceptionally dry or because exceptionally acidic in composition, the explosively expanding steam and other gases inflate it into pumice, or even blow it into dust; while if exceptionally fluent, by reason either of wetness or of basic composition, the explosion is less violent, the steam bubbles out as from boiling liquid, and the lava flows over the crater-rim, or through some chasm rent by its own enormous weight, in streams extending perhaps for many miles—as in Kilauea in 1841, and in the New Mexican volcano near Grant shortly before the Columbian discovery. Commonly it happens that the lighter lavas first extruded are the more viscous, the later and heavier material more fluent; so that the initial manifestation is commonly more decidedly explosive, the action then running down to relatively quiescent outflow; and their other relations depending on composition of the lava, etc., too complex for ready summing.

In the light of the natural history of vulcanism, and of the mechanism traced through the phylogeny of the volcano, the Antillean eruptions may readily be placed in the general scheme of knowledge. Both Mont Pelee and La Souffriere lie in a volcanic province in which the activity culminated ages ago, so that their activity may be likened to the dying throes of a Vulcanean giant; and this fact, while by no means to be interpreted in definite prophecy, is one of some promise to future generations. Again, both volcanoes approach the Krakatoan character rather than the innocent type of Stromboli; this character is destructive in itself; moreover, in view of the normal passage from initial explosion to final outwelling of quiet lava streams, it is to be regarded as an indication either (1) that the crisis of the spasm is not yet passed, or (2) that the andesitic lavas thus far outcast are precursors of more completely differentiated matter to be erupted during coming millenniums. In either case the outlook is less roseate than the humanitarian student would wish; for the fact that the region is one in which vulcanism is decadent when it is measured by geologic ages is of far less immediate interest than the prospect measured either in days of the single vulcanean spasm, or in millenniums of the life history of particular vents.

SCIENTIFIC LITERATURE.

ZOOLOGY.

A PLAUSIBLE explanation of the occurrence of peculiarities of structure and coloration in the males of many animals, both vertebrate and invertebrate, was first given by Darwin in his theory of sexual selection. Objections have been raised, however, to that portion of the theory which concerned ornamental peculiarities on the ground that the existence of an esthetic sense sufficiently acute to account for the minute and complex details of coloration is in many cases improbable, and from time to time other theories have been advanced which sought to avoid this difficulty. Among these may be mentioned the theory of Wallace, to the effect that the greater ornamentation of the male is due to his 'surplus of vitality'; that of von Kennel, which is essentially a negative statement of Wallace's, holding that the drain upon the vitality of the female in the production of ova prevents the full fruition of development seen in the males; and the sacrificial theory of Jäger and Stolzmann, according to which the brilliancy or excessive development of the male conduces to his destruction whereby the female is indirectly protected and the male is removed from competition with her in the struggle for nourishment.

But all these theories are open to the criticism either that they are too general or that they fail to explain the origin of the sexual peculiarities, and, recently, Professor J. T. Cunningham, in his 'Sexual Dimorphism in the Animal Kingdom' (A. and C. Black, 1900), has endeavored to avoid both these objections by discarding natural selection in all its forms and relying upon the Lamarckian hypothesis. He regards secondary sexual characters as being due to the inheritance of the effects of definite mechanical and physiological irritations, and endeavors to correlate the peculiarities of various species with their habits. Thus he explains the mane of the lion not as a protection, but as the result of the local irritation of the skin due to the habit possessed by fighting lions of seizing one another by the nape of the neck; the coloration and furrowing of the cheek of the mandrill are due to the inheritance of irritations and injuries inflicted by the males in combat; the plumes of the birds of paradise have reached their extensive development by having been erected during sexual excitement and so stimulated to special growth through many generations, and the naked head and neck of the turkey-cock and his wattles represent 'the inherited scars of a long line of pugnacious ancestors.' These examples, and they are by no means extreme, may serve to indicate the general tenor of Professor Cunningham's argument, and it seems more than doubtful if he has strengthened the Lamarckian position or provided valid evidence for the overthrowal of the theory of sexual selection.

THE PROGRESS OF SCIENCE.

THE AMERICAN ASSOCIATION.

THE American Association for the Advancement of Science will hold its fifty-first annual meeting at Pittsburgh, beginning with a session of the council on June 28 and with the first regular session of the Association on June 30. The time and place of meeting seem to be favorable to a large attendance and a good program. There is reason to suppose that the first of July is more satisfactory than the usual date, the middle of August, as men of science are then so widely scattered that it is difficult for them to come together. Pittsburgh is certainly a central point, as easily reached by railways from all parts of the country as any in America. An unusual concession has been made by some of the railways in extending the return limit of tickets until the end of August, thus accommodating those who wish to make the meeting at Pittsburgh the opening of their summer holidays. Under the direction of the chairman of the local committee, Dr. W. J. Holland, and the local secretary, Mr. George A. Wardlaw, an elaborate announcement has been published; and it appears that excellent arrangements have been made for the success of the meeting.

The address of the retiring president, Professor C. S. Minot, of the Harvard Medical School, which we hope to have the privilege of publishing in this journal, will set a high standard for the addresses of the vice-presidents which they will undoubtedly meet, for they are among our leading men of science—Professor James MacMahon in mathematics; Professor D. B. Brace in physics; Professor H. S. Jacoby in engineering; Professor C. R. Van Hise in geology; President David Starr Jordan in zoology; Mr. B. T. Galloway in botany; Dr. J. Walter Fewkes in anthropology, and Mr. John Hyde in social science.

The American Association has become a center of affiliation for a large number of special scientific societies. Thus it is expected that there will meet at Pittsburgh, either at the same time as the association, or just before or after, the national societies devoted to chemistry, geology, botany, agricultural science, microscopy, entomology, folk-lore, engineering education and physics. These and other societies that will join with the association at its next meeting are represented on its council, which thus becomes a representative body competent to legislate on behalf of the interests of science and scientific men. The special papers tend increasingly to be presented before the societies affiliated with the association, while the association itself retains the function of representing science before the general public. Only men of science belong to the special societies, but all those interested in science are eligible for membership in the association. As a matter of fact, its three thousand members are nearly equally divided between those who are professionally engaged in scientific work and those who take an interest in and wish to assist in such work. Members have the privilege of attending the meetings of the association and of its affiliated societies, enjoying the reduced fares on the railways and the arrangements for entertainment, this being much more than a return for the small annual membership fee ($3). Even those unable to attend the meetings have now a full

return, as they not only receive the volume of the proceedings, but also the weekly journal *Science*. But even apart from these practical advantages, it is desirable that all those who wish to further the advancement of science in America should ally themselves with the association. Information in regard to the conditions of membership may be obtained from the permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.

PRESIDENT ASAPH HALL.

ONE of the greatest of the world's astronomers will preside over the Pittsburgh meeting of the American Association. Dr. Hall has obtained a wide reputation by the discovery of the satellites of Mars, and among astronomers his continuous observations at the Naval Observatory from 1863 onward are recognized as of the highest value. He has also taken part in a number of important government expeditions, including one to Bering Straits in 1869 to observe the eclipse of the sun—to Sicily in 1870, and to Colorado in 1878 for the same purpose; and to observe the transit of Venus in Siberia in 1874 and in Texas in 1882. While the life of a man of science is usually uneventful, Dr. Hall's early career is full of interest. His father died when he was thirteen years old, and he took charge of the farm. He then became a carpenter; and, having saved a little money, at the age of twenty-five years went to a small college in New York State. There he married one of his fellow students. He taught school and studied at the University of Michigan, where he became interested in astronomy under Professor Brünnow. In 1857, when he was twenty-eight years old, he obtained a position in Harvard College Observatory under Professor Bond, with a salary of $3 a week. Appointed professor of mathematics in the U. S. Navy at the beginning of the year 1863, he worked first with the 9½-inch equatorial; from 1868 to 1875 he was in charge of the small equatorial, and from 1875 until his retirement in 1891 he was in charge of the 26-inch equatorial. Dr. Hall was professor of astronomy at Harvard University from 1895 until last year. He is vice-president of the National Academy of Sciences and a member of many foreign scientific academies. He has received the gold medal of the Royal Astronomical Society, and the Lalande prize and the Arago medal of the Paris Academy of Sciences; he has received the degree of LL.D. from Yale and Harvard Universities and many other honors. A recent portrait of Dr. Hall is given as a frontispiece; an earlier portrait and an extended biographical sketch will be found in the issue of THE POPULAR SCIENCE MONTHLY for October, 1894.

AN AMERICAN ANTHROPOLOGICAL SOCIETY.

WHILE we have in this country societies for nearly all the sciences, a society for anthropology has not hitherto been established. The section of the American Association representing anthropology has to a certain extent filled the function of a special society, having in recent years held a separate meeting in mid-winter. The time, however, appears to have come when a national anthropological society can be established to advantage, and the formation of such a society is now under discussion. Professor Franz Boas, in a paper read before the Anthropological Society of Washington, presented very clearly the need of such a society and the precautions that should be taken in its establishment. He points out that anthropology is one of the subjects in which there is a considerable popular interest, without a very large body of well-trained specialists, and that there would be some danger in establishing a society to which every one would be admitted. Not only might the meetings of such

a society assume the character of popular lectures, but it might interfere with the proper work of the American Association for the Advancement of Science. Professor Boas proposes that a national society be established in cooperation with the American Association, and the council of the association has appointed a committee to consider the plan. It contemplates all members of the Anthropological Society being members of the American Association, assuming for the special society the conduct of the special papers and discussions, and leaving to the general association such steps as may be desirable for the popularization of the science. This plan appears to be in the line of development. We need in each center societies composed of specialists in a given department. These societies should unite, on the one hand, to form a local academy and on the other to form a national scientific society. Then, in addition to these special students, it is important that all those who wish to ally themselves with science and to assist in its development should be permitted to become members both of the local academy and of the national association.

THE ROYAL SOCIETY'S CONVERSAZIONE.

It is an open question whether it is for the interests of science that there should be in a country a number of small centers or one chief capital where its intellectual life is gathered. The civilizations of Greece, Italy and Germany seem to have been advanced by their competing cities and principalities, whereas France and England seem to have profited by the great concentration in Paris and in London. The Paris Academy of Sciences and the London Royal Society occupy positions unrivaled by the societies of other countries; and there are certainly very great advantages in the intimate union of all the men of science of a country in a single society. These advantages are illustrated by the conversaziones annually held by the Royal Society at which are exhibited the scientific advances of the year. A similar exhibition and reception was for several years held by the New York Academy of Sciences, and it is to be hoped that this may be resumed. It can not be expected, however, that the scientific advances made in a single city of the United States will compare with those of London which represent in large measure those of the whole kingdom.

It appears from the descriptive catalogue that there were fifty-six exhibits at the conversazione of the Royal Society held on May 14. They all represent valuable scientific advances, but without any really noteworthy discovery, so that it is somewhat difficult to select any of the exhibits for special mention. The new fields opened up by the discoveries of the X-rays and of the inert gases of the atmosphere, have ever since furnished material for the exhibits. This year, for example, Mr. Davidson showed an X-ray stereoscope, Mr. Cossor a new tube and Mr. Pidgeon a new electrical influence machine for X-ray work, while Professor Ramsay exhibited a vacuum tube containing crypton, the color of which appears to some observers to be lilac and to others green. Other physical exhibits were a kymograph in which the writing pen is moved instead of the drum, an improved coal calorimeter and an electricity meter. Color photography was well represented, apparatus being shown and exhibits made, those of special interest being in photomicrography. The methods of manufacture of synthetic indigo, now threatening to supersede the use of the indigo plant, were exhibited. The Marine Biological Association presented an exhibit showing how the age of fishes is indicated by the growth of layers of scales somewhat similar to the eccentric lines on the section of the trunk of a tree. The School of Tropical Medicine exhibited a parasite from

human blood resembling that found in animals suffering from the tsetse fly disease. Several of the exhibits were more or less connected with America. Thus Dr. Roberts showed lantern slides in natural colors of the Canyon of the Colorado and the Yellowstone Park, and similar American scenes painted by Miss Breton were exhibited. Professor Schuster exhibited a Rowland grating of one meter focus arranged to show the lines of iron in the flame of a Bunsen burner. Professor Lankester exhibited models of deep-sea fishes, based in part on the figures and text of Goode and Bean's 'Oceanic Ichthyology,' while the Royal Astronomical Society exhibited photographs of the nebula surrounding Nova Persei taken at the Yerkes Observatory.

PRINCETON UNIVERSITY.

THE Rev. Dr. Francis L. Patton, who succeeded the Rev. Dr. James McCosh as president of the College of New Jersey in 1888, resigned the presidency of Princeton University on June 9, and the trustees immediately elected as his successor Dr. Woodrow Wilson, McCormick professor of jurisprudence and politics. It would be pleasant to join in the general expression of surprise at President Patton's resignation, of admiration for his administration and of eulogy of his successor. But principles are more important than men; and this journal represents certain principles at variance with the policy of the authorities of Princeton University. President Patton's resignation was not a surprise to those familiar with the inside history of the university, nor do they regard the material growth of Princeton in money and men during the past fourteen years as due to him. Dr. McCosh was in advance of his church and his college; he did much to forward the teaching of organic evolution and of psychology as a science. Dr. Patton was once a hunter down of heretics in his church; the ethics that he teaches are but little concerned with the principles of evolution or of psychology. He has an acute mind of a scholastic turn and an attractive individuality; but his influence at Princeton has not been great.

Through the loyalty of its alumni, Princeton has increased in wealth and in numbers under President Patton's administration; but nothing has been done to justify the change of name from college to university. Fourteen years ago Harvard, Yale and Princeton might with some reason have been mentioned as our leading institutions of learning; now Princeton can be ranked with Harvard, Columbia and Chicago only by those who gain their information from the pages of the daily press devoted to athletic sports. Princeton has no school of law or of medicine. The theological seminary in the village represents the least progressive elements in the Presbyterian church. The last catalogue of Princeton University contains the names of 117 graduate students, but sixty-eight of them live in the halls of the theological seminary. Princeton has a school of science; but its students must take thirteen and a half hours in language (including Latin) as compared with eight hours in science; they are not permitted to begin the study of physics until the junior year.

There is reason to doubt whether President Wilson will accomplish at Princeton what President Hadley may be expected to accomplish at Yale. Dr. Wilson is a brilliant essayist; like his predecessor, he is one of the few college presidents who can speak with credit on the same platform as President Eliot. But from the scientific point of view, there is not a great difference between the literary-theological and the literary-legal mind. When Dr. Eliot in 1869 resigned the professorship of chemistry in the Massachusetts Institute of Technology and was installed as president of Harvard University, he laid down a program of

progress to which his administration has been devoted. The recently installed presidents of Yale, Johns Hopkins and Columbia have thought it wiser to confine their inaugural addresses to generalities, and there is reason to suppose that the president of Princeton will follow their example. We therefore reprint above the concluding part of the official oration given by him on the occasion of the Sesquicentennial Celebration of Princeton University. President Wilson's attitude toward science might be misstated; it is better to let him speak for himself.

THE ABUSE OF ALCOHOLIC TEACHING.

THE success of certain well-meaning but intemperate women in securing the enactment of laws requiring the teaching in the public schools of the injurious effects of alcoholic beverages, etc., is now receiving serious attention. Professor W. T. Sedgwick, in his presidential address before the Chicago meeting of the American Society of Naturalists, and the New York State Science Teachers Association, through the report of its committee, give the subject the attention it deserves. The question is certainly complicated, opening up many problems in sociology, education, psychology and morals which can not be settled off-hand. Whether the moderate use of alcohol is injurious, whether the attempt should be made to prevent its excessive use by law, whether its dangers should be taught to children, are questions to which science can not give a definite answer. On the other hand, there is substantial agreement on the part of educators and scientific men that the existing laws prescribing the constant teaching of the dangers of alcohol as part of the science of physiology are undesirable. In the state of New York, for example, all children below the second year of the high school and above the third year of school work—say from the ages of nine or ten to fifteen or sixteen years—must have thirty lessons a year on the effects of alcohol, etc. The lessons must be one fifth of the work in physiology and hygiene and the subject must be treated in connection with the various chapters. Further the text-books in physiology are practically supervised by Mrs. Mary H. Hunt, who calls herself 'World and National Superintendent of the Department of Scientific Temperance of the Woman's Christian Temperance Union.' Now it is evident that all that is known in regard to the effects of alcohol on the tissues can be told in an hour or two; the arguments against its use are economic and moral. If morals are to be taught in the public schools, as is the case in France, the issue should be fairly met. If temperance is a proper subject for instruction, it is reasonable to assume that the abuse of alcohol should not receive more attention than the abuse of legislation and physiology, as exemplified by what Mrs. Hunt calls 'organized motherhood.'

SCIENTIFIC ITEMS.

WE note with regret the death of Professor Adolf Kussmaul, of Heidelberg, eminent for his work on aphasia and other forms of nervous disease; of Mr. George Griffith, assistant general secretary of the British Association for the Advancement of Science, and of Professor Emmett S. Goff, who held the chair of horticulture at the University of Wisconsin.

THE Geological Society of London has elected as foreign correspondents Professor T. C. Chamberlin, of the University of Chicago; Professor S. W. Williston, just called to the University of Chicago, and Dr. T. Thoroddsen, of Iceland.—The Linnean Society of London has elected among four foreign members Professor C. S. Sargent, of Harvard University.—Dublin University will confer the degree of

Doctor of Science on Professor J. Willard Gibbs, of Yale University.—The Hon. James Wilson, Secretary of Agriculture, and Dr. B. F. Galloway, chief of the Bureau of Plant Industry, have received the degree of LL.D. from the Missouri State University.—Dr. Carlos Finlay, of Havana, eminent for his work on yellow fever, has been given the degree of Doctor of Science by Jefferson Medical College, from which he graduated in 1855.

THE Senate has passed a bill authorizing the Commissioner of Fish and Fisheries to establish a biological station on the Great Lakes.—Plans have been prepared for the erection of a bacteriological laboratory in Washington, under the control of the Marine Hospital service.—Yale University has received for the Sheffield Scientific School a new building for mineralogy, geology and physiography.—A new building, chiefly for surgery, is to be erected for the Johns Hopkins Medical School at a cost of $100,000.—Friends of Columbia University have purchased from the New York Hospital for $1,900,000 the two blocks of land facing the University. It is hoped that this land may be ultimately acquired for the use of the University.—The final appraisement of the estate of the late Jacob S. Rogers shows a value of $6,063,173. After deducting the costs of administration and the legacies it is estimated that the residuary estate which will go to the Metropolitan Museum of Art under the will is $5,547,922.60.—According to an official statement recently issued the endowment of the Nobel Foundation is about $7,500,000, and the value of each of the five prizes to be awarded at the close of the present year will be nearly $40,000.

AT the annual meeting of the American Academy of Arts and Sciences, held on May 14, it was voted to award the 'Rumford Premium' to Professor George Ellery Hale, of the Yerkes Observatory, 'for his investigations in solar and stellar physics, and in particular for the invention and perfection of the spectro-heliograph.' It was also voted to appropriate the sum of $750 from the income of the Rumford Fund to be expended for the construction of a mercurial compression pump designed by Professor Theodore W. Richards and to be used in his research on the Thomson-Joule effect. An appropriation from the Rumford Fund was also made to Professor Arthur A. Noyes in aid of his research upon the effect of high temperatures upon the electrical conductivity of aqueous solutions.

IN connection with the proposal to enlarge the Royal Society so as to include representatives of the historical, philological and moral sciences, or to establish a new academy for these sciences, Mr. Charles Waldstein, of King's College, Cambridge, has proposed the establishment of an Imperial British Academy of Arts and Sciences, which would include four sections as follows: The Royal Society for the natural and mathematical sciences, a new Royal Society of Humanites for the historical, philological and moral sciences, the present Royal Academy for painting, sculpture, architecture and the decorative arts, and a new Royal Academy of literature and music.